Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

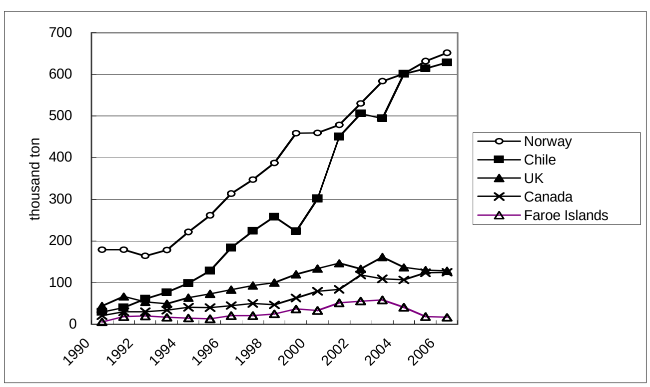

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

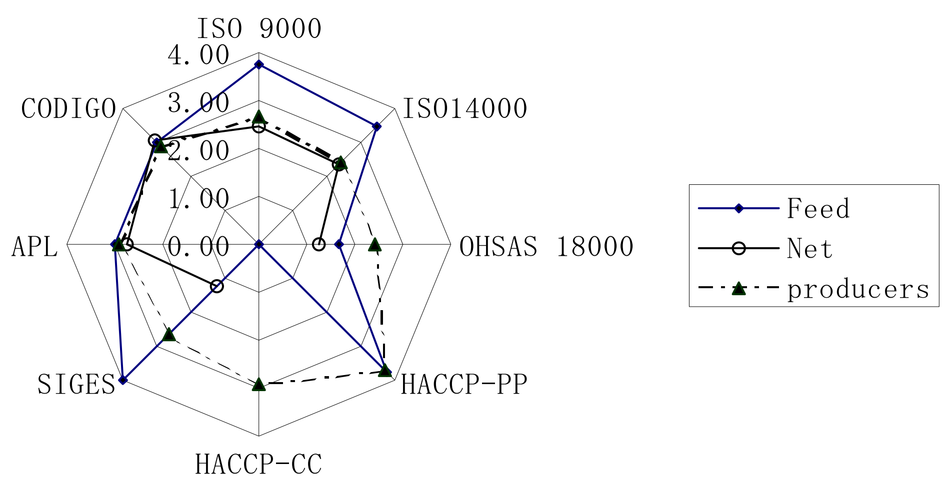

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

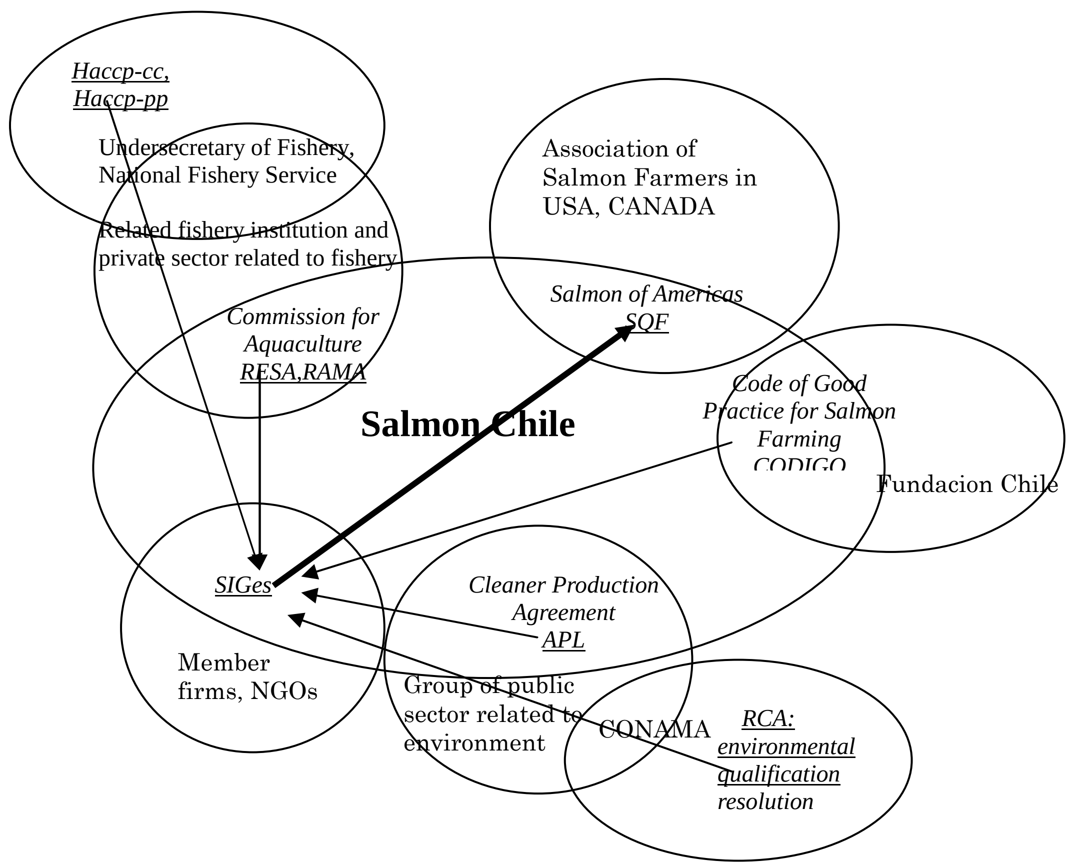

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

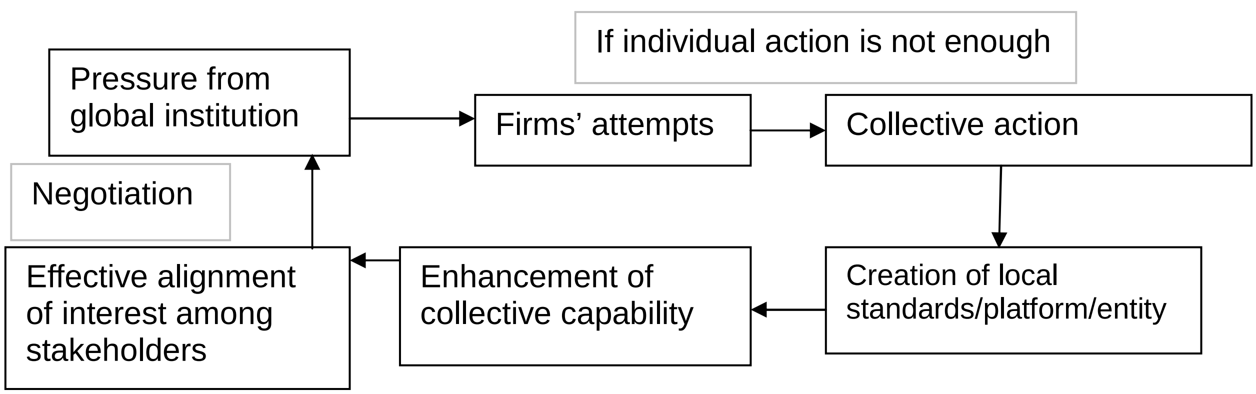

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

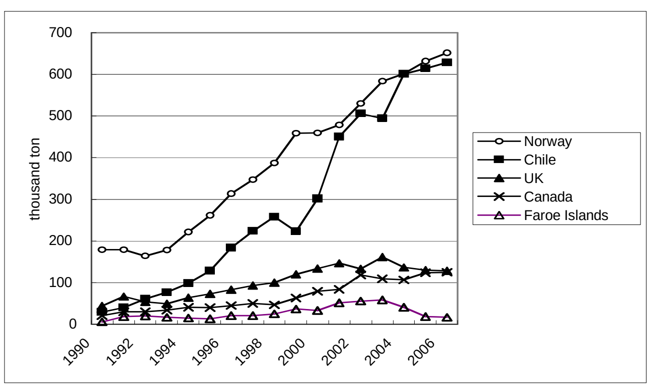

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

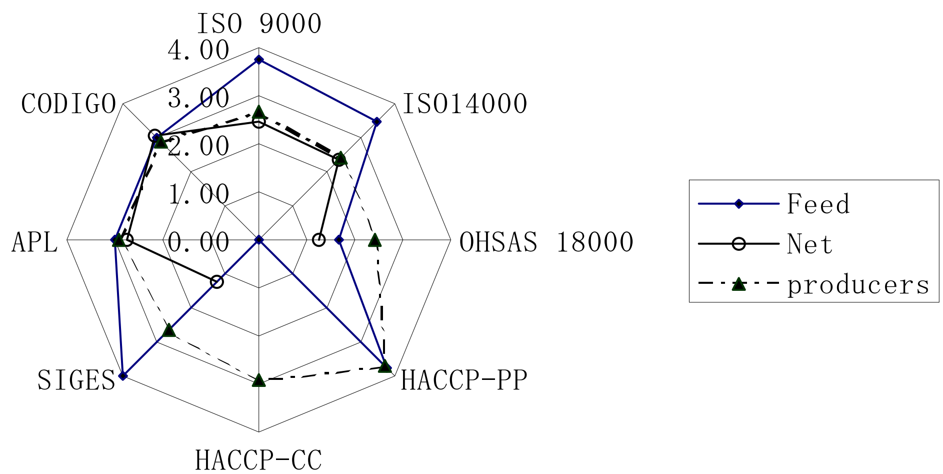

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

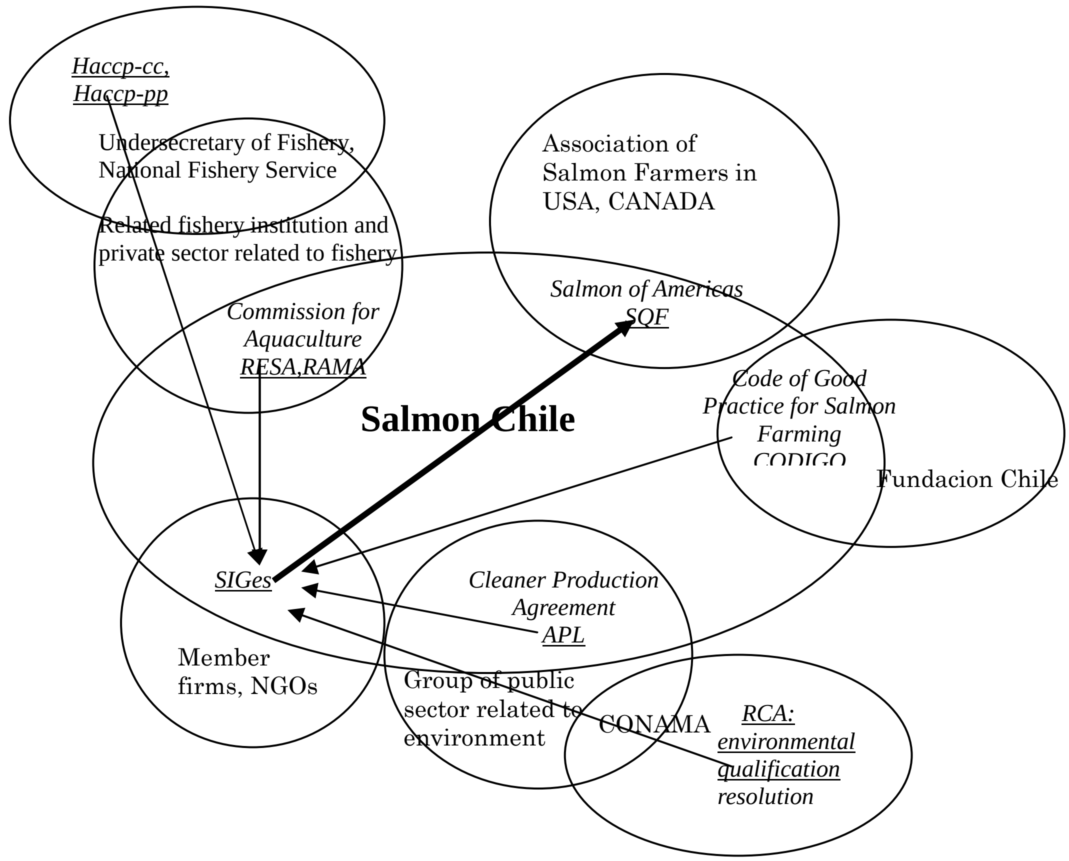

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

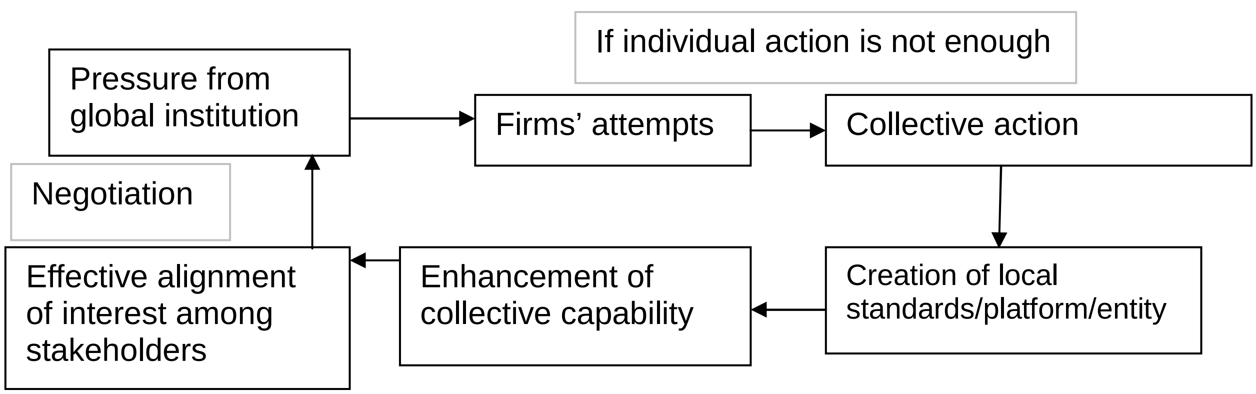

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

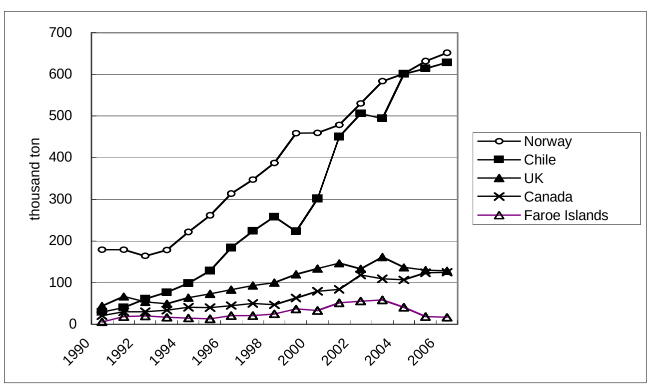

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

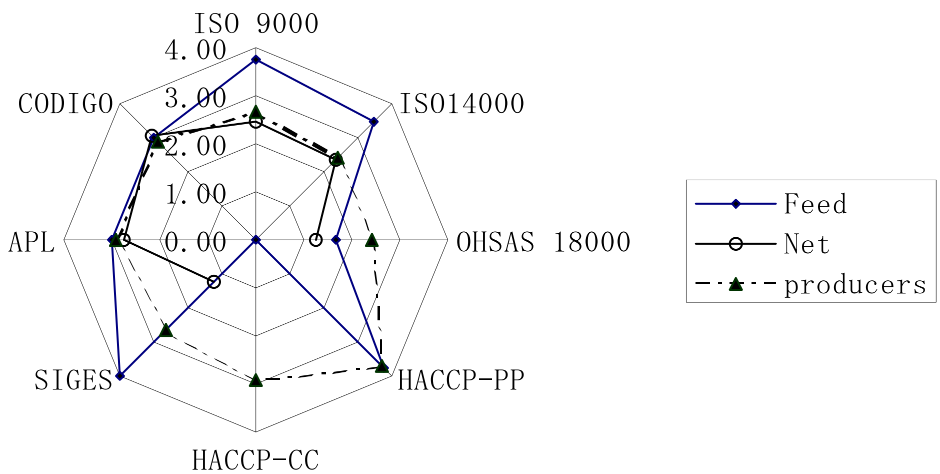

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

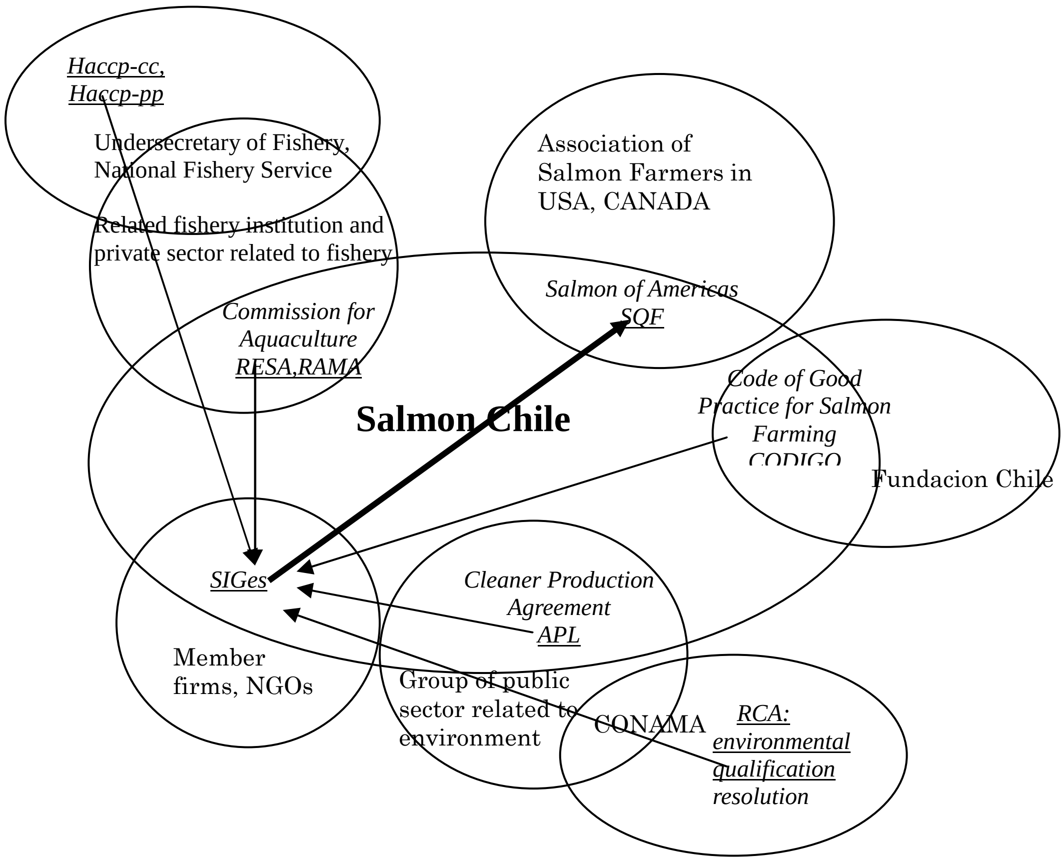

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

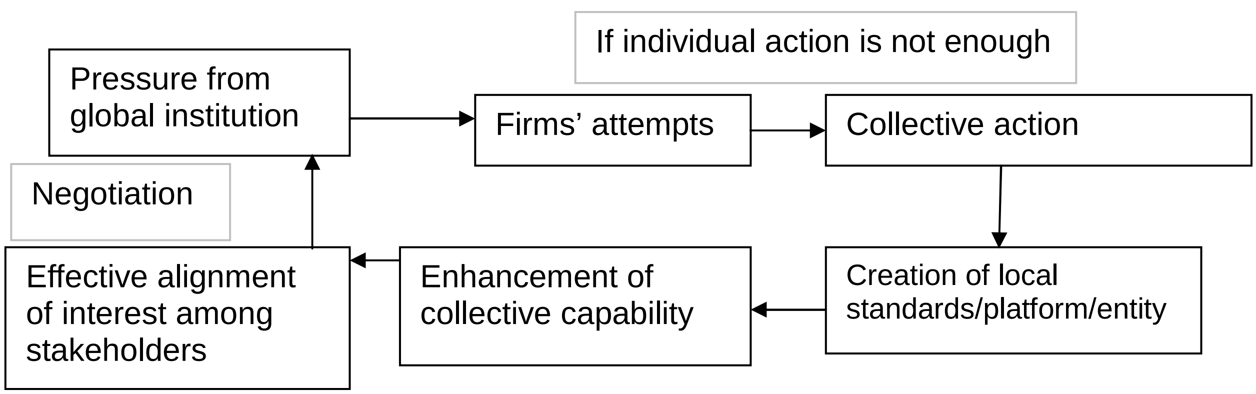

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are 'governed' by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through 'copying' and 'adapting' to the exogenously determined standards, then through 'imitating' and 'integrating'; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of 'countervailing power' has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple 'commodity trap' (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that "covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides" (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able "to address rapidly changing environments" (Teece, Pisano and Shuen, 2000: 516). Similarly, 'absorptive capacity' (Cohen and Levinthal, 1990: 128) identifies the "ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability." They claim that absorptive capacity is determined by the firm's prior related knowledge – often the prior investment in R&D.

In other words, 'capability' is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

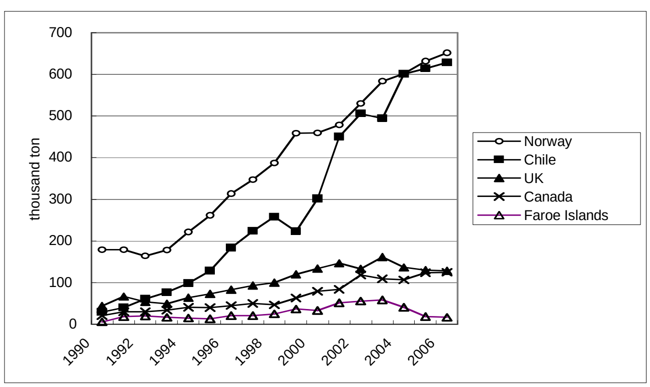

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

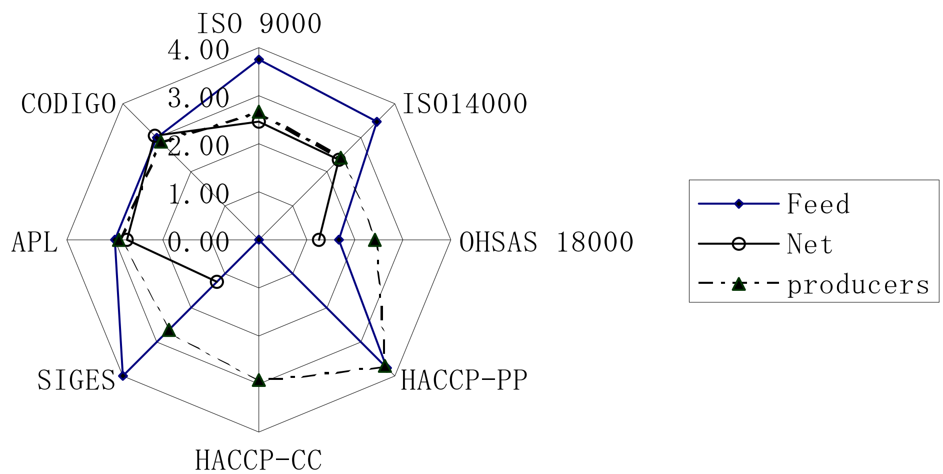

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

•ISO 9000:	A global standard for quality management
•ISO 14000:	A global standard for environmental management
•OHSAS 18000:	A global standard for occupational health and safety

Local standards: adapted versions of global standards

•HACCP-CC:	Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
•HACCP-PP:	Same as above but for the fish-meat processing plants.
•APL:	Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
•SIGes:	Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
•CODIGO:	Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the 'cleaner production initiative' which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the 'adaptation' and 'modernization' stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

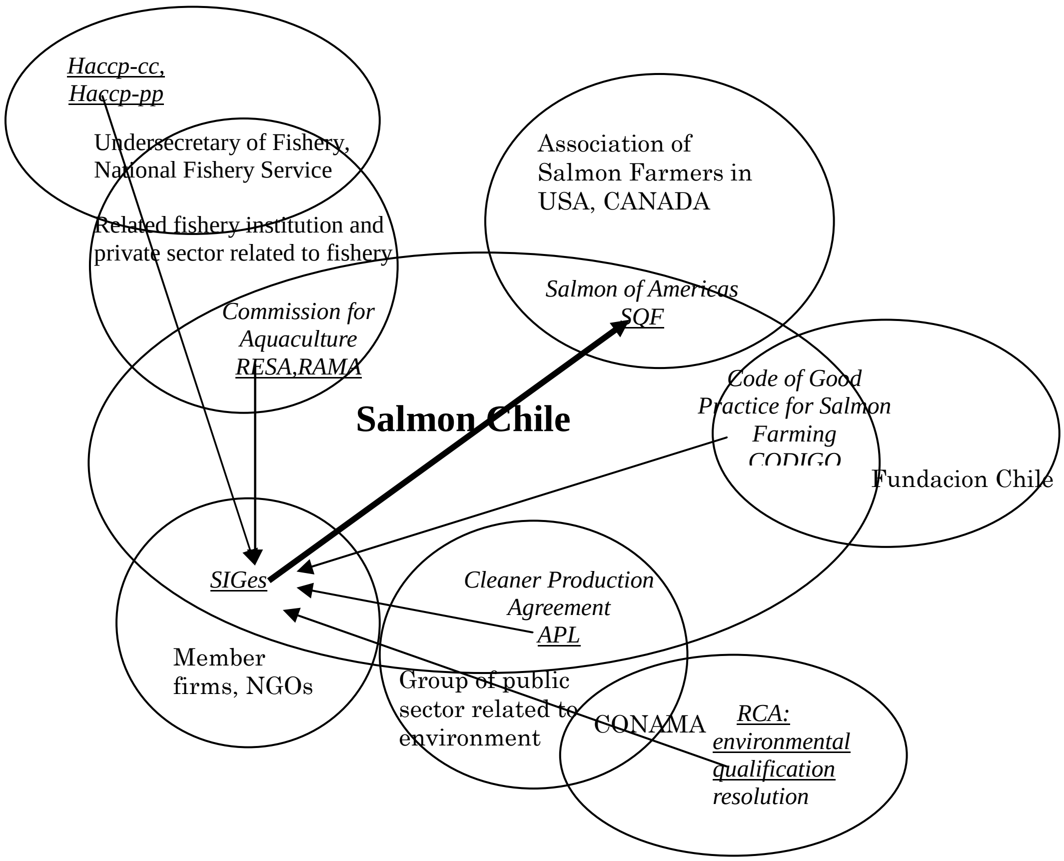

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

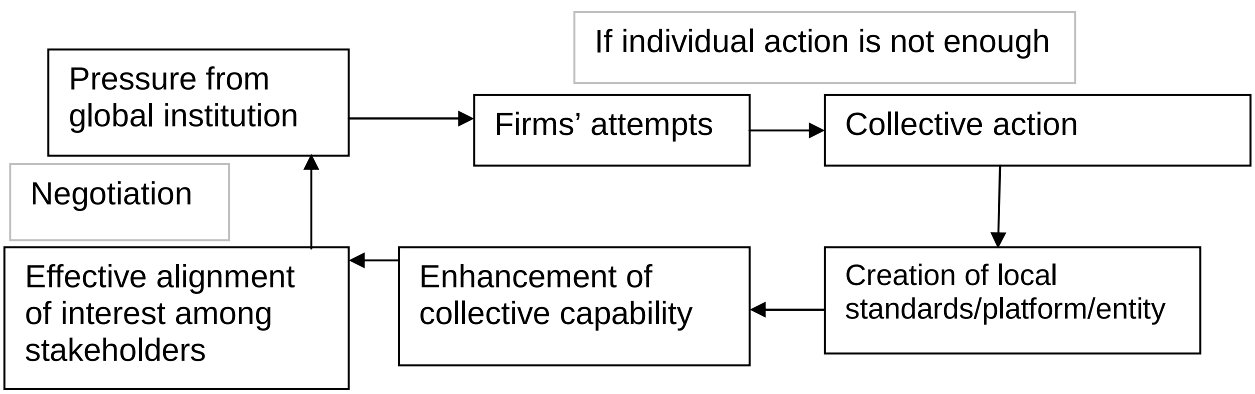

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

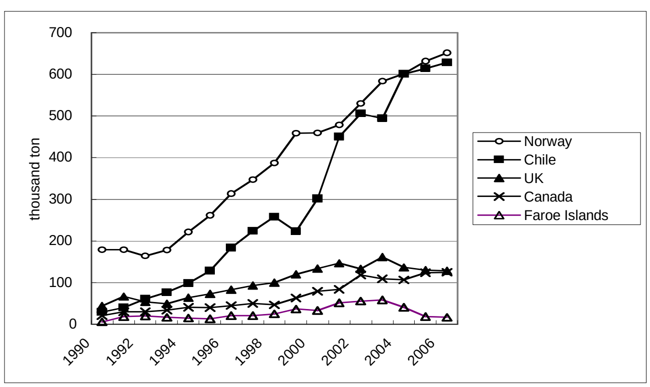

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

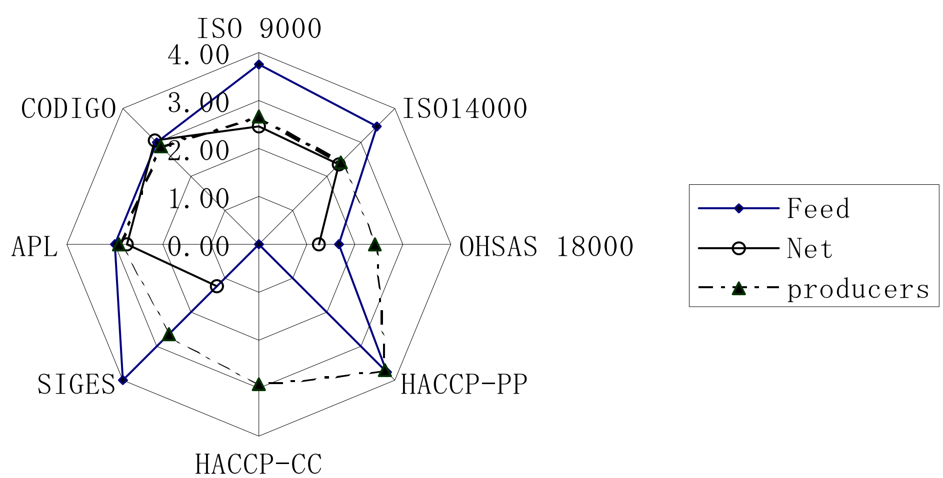

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the 'cleaner production initiative' which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the 'adaptation' and 'modernization' stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

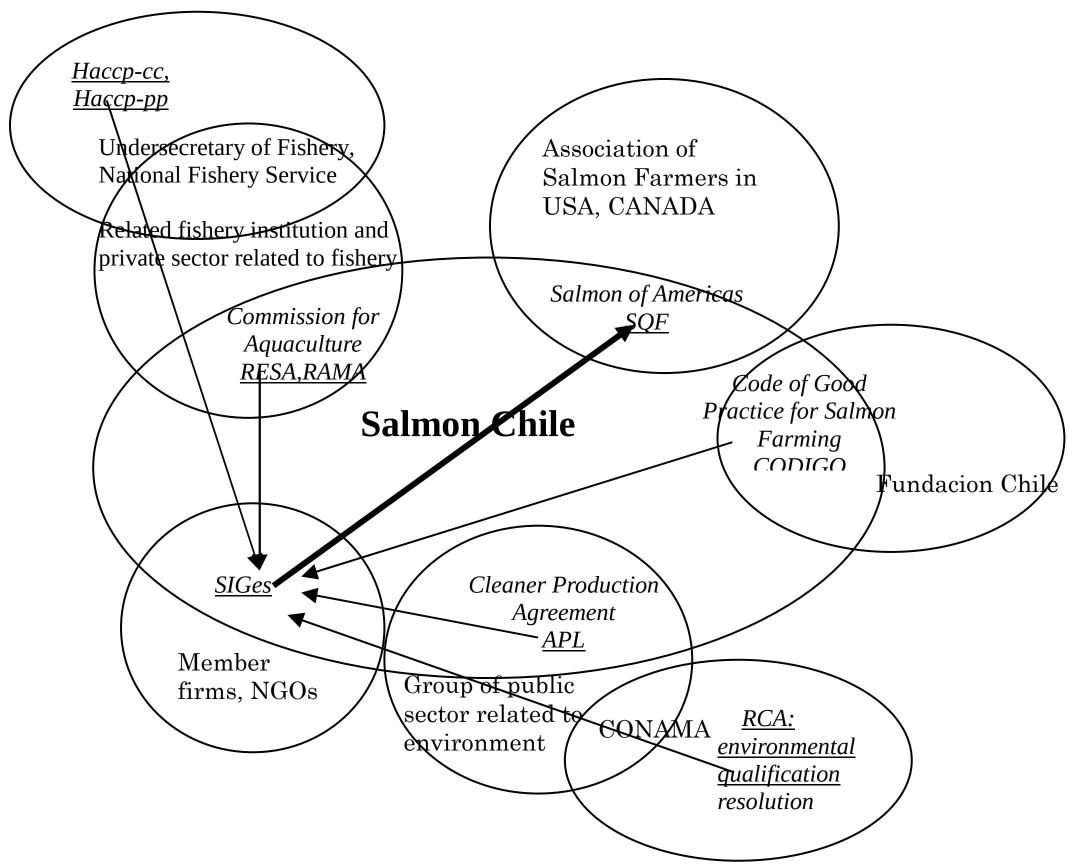

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

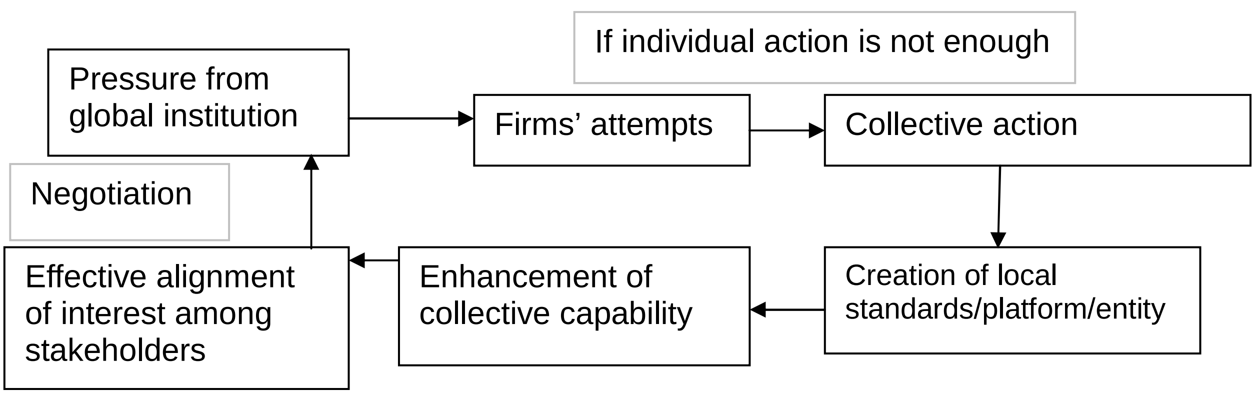

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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UNU-MERIT Working Papers intend to disseminate preliminary results of research carried out at the Centre to stimulate discussion on the issues raised.

1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are 'governed' by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through 'copying' and 'adapting' to the exogenously determined standards, then through 'imitating' and 'integrating'; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of 'countervailing power' has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple 'commodity trap' (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that "covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides" (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able "to address rapidly changing environments" (Teece, Pisano and Shuen, 2000: 516). Similarly, 'absorptive capacity' (Cohen and Levinthal, 1990: 128) identifies the "ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability." They claim that absorptive capacity is determined by the firm's prior related knowledge – often the prior investment in R&D.

In other words, 'capability' is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

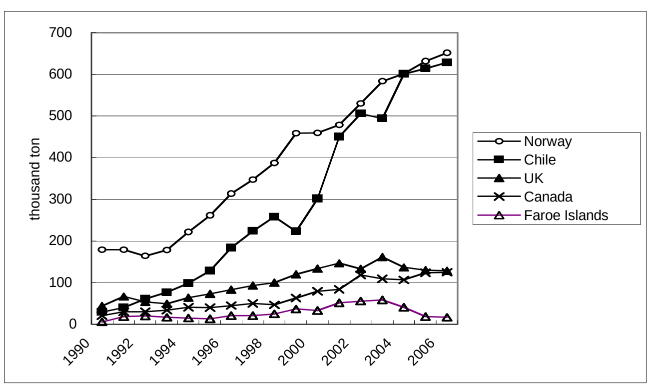

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

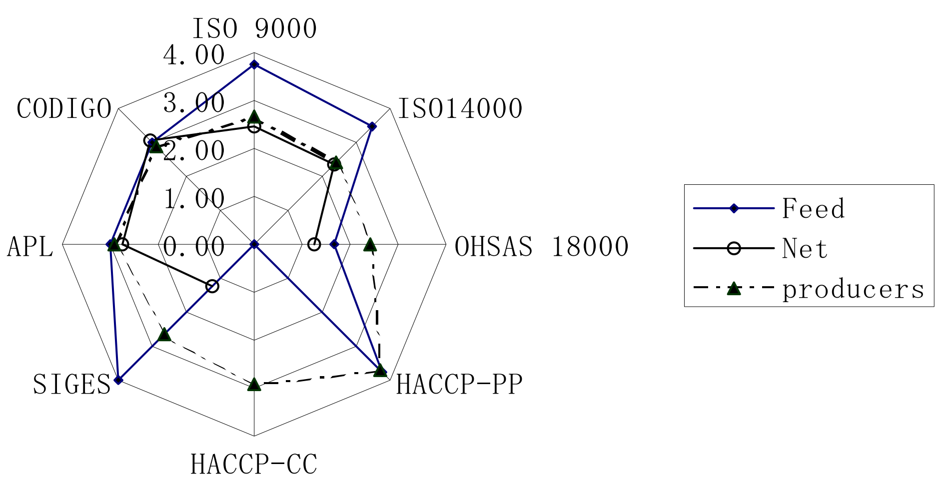

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were ‘EXPERIENCE’, ‘SALES’, ‘PROF’ and ‘ASOC’, for the standards compliance scores, ‘all’, ‘international’ and ‘local’. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, ‘SALES’ is a single variable that affects the higher compliance level, while for local standards, ‘PROF’ and ‘ASOC’ are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, ‘SALES’. It is, however, worth observing that firm-level technological capacity represented by ‘PROF’ and collective capacity represented by ‘ASOC’ are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

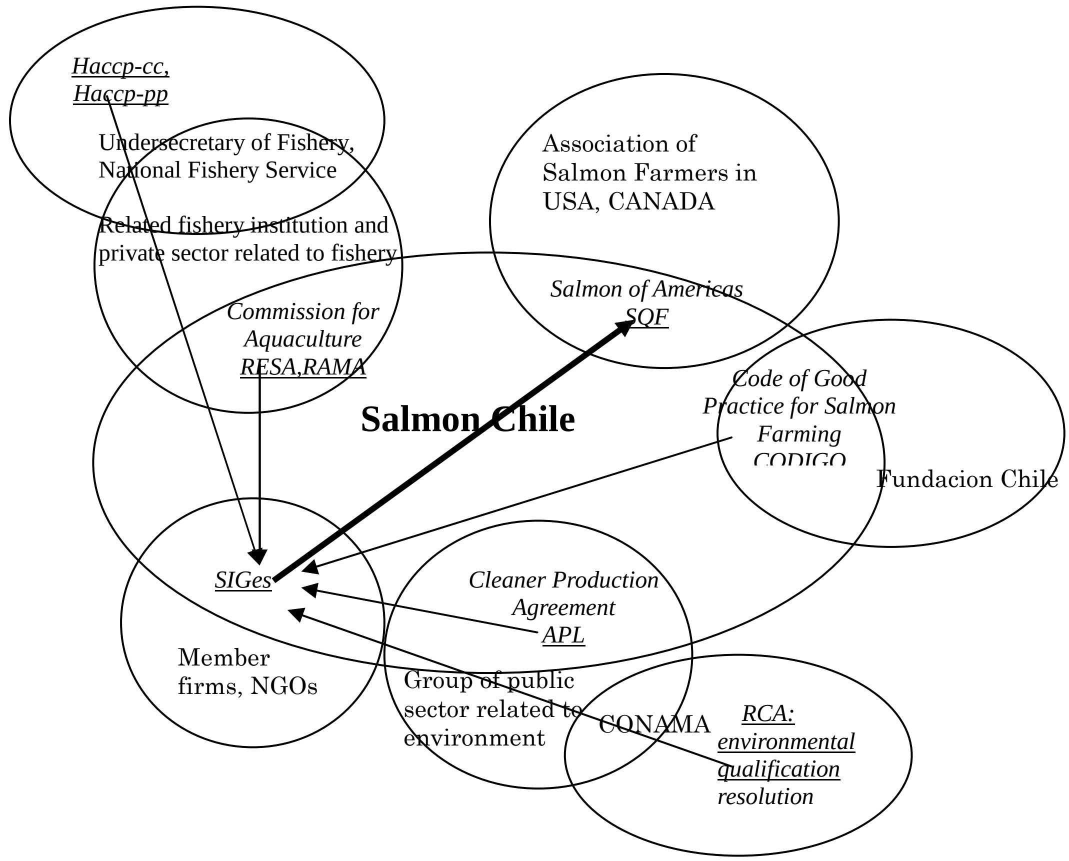

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

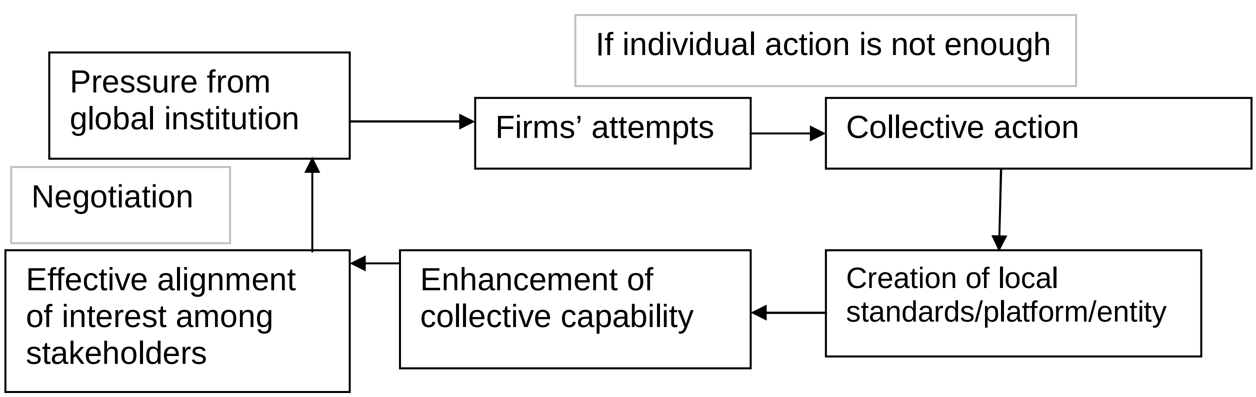

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available 'know-how' with the knowledge of 'know who'. Their argument suggests that for standards, to comply successfully with the 'know what', needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling's model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, 'know how' – here the skills to comply – and particularly 'know who' – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both 'bottom up' and 'top-down' (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or 'countervailing power' as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are 'governed' by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through 'copying' and 'adapting' to the exogenously determined standards, then through 'imitating' and 'integrating'; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of 'countervailing power' has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple 'commodity trap' (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that "covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides" (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able "to address rapidly changing environments" (Teece, Pisano and Shuen, 2000: 516). Similarly, 'absorptive capacity' (Cohen and Levinthal, 1990: 128) identifies the "ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability." They claim that absorptive capacity is determined by the firm's prior related knowledge – often the prior investment in R&D.

In other words, 'capability' is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

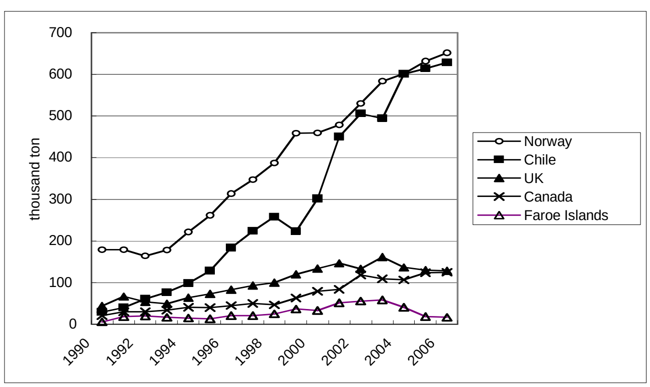

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

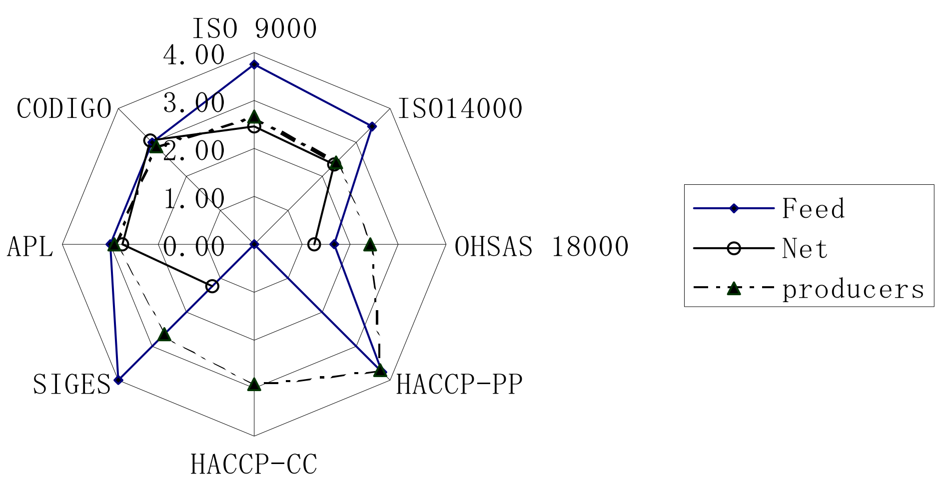

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

‘AGE’ is the firm’s total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

‘PROF’ expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable ‘SALES’ demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

‘ASOC’ is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

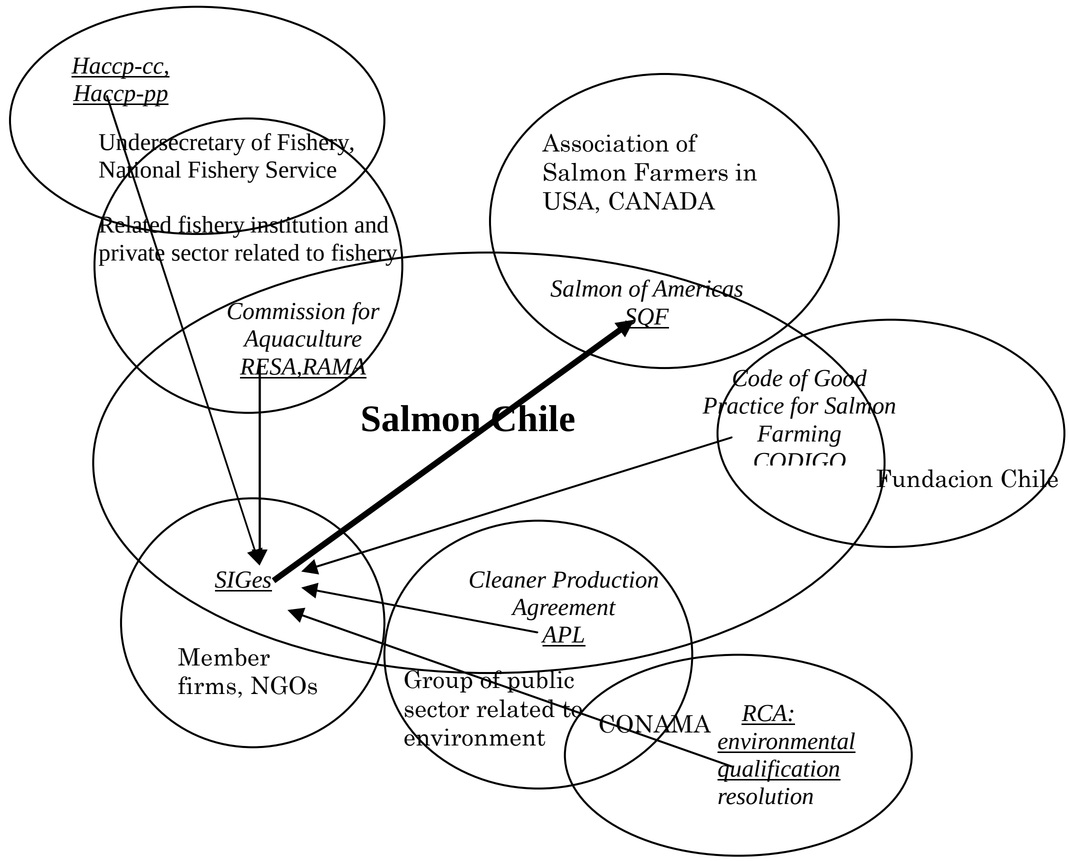

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

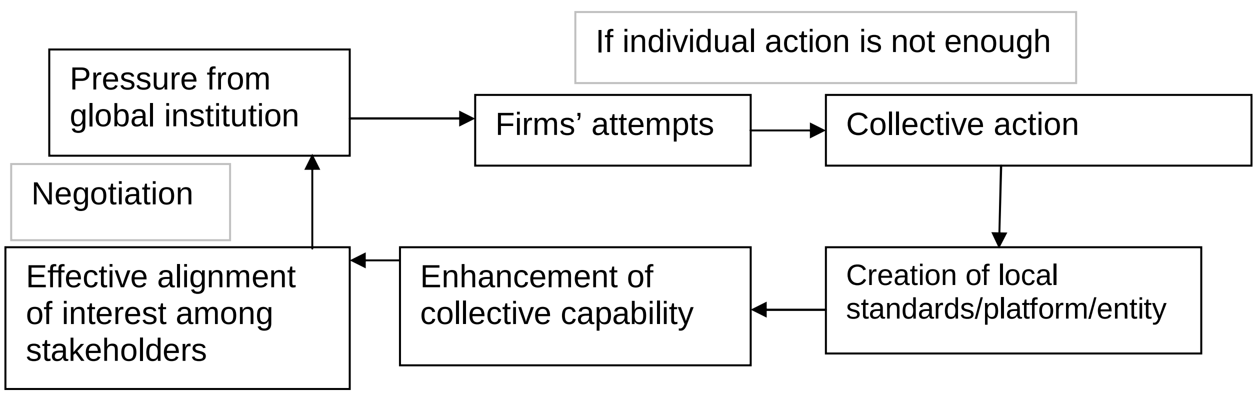

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words

Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

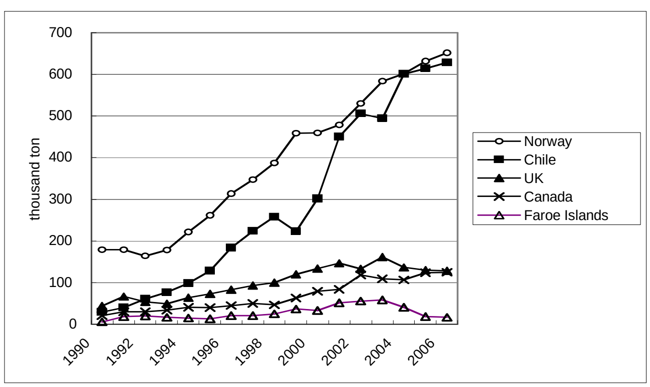

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

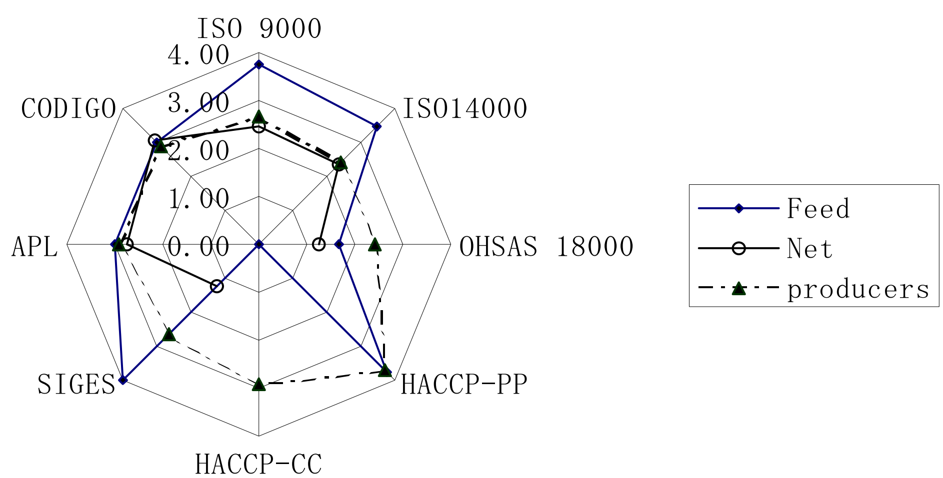

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

•ISO 9000:	A global standard for quality management
•ISO 14000:	A global standard for environmental management
•OHSAS 18000:	A global standard for occupational health and safety

Local standards: adapted versions of global standards

•HACCP-CC:	Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
•HACCP-PP:	Same as above but for the fish-meat processing plants.
•APL:	Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
•SIGes:	Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
•CODIGO:	Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 *** (5.510)	1.232 *** (6.160)	3.907 *** (5.063)
Sales		0.016 ** (4.085)	
EXPERIENCE			
PROF	0.028 ** (2.121)		0.013 ** (2.195)
ASOC	5.658 ** (2.046)		2.195 * (1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

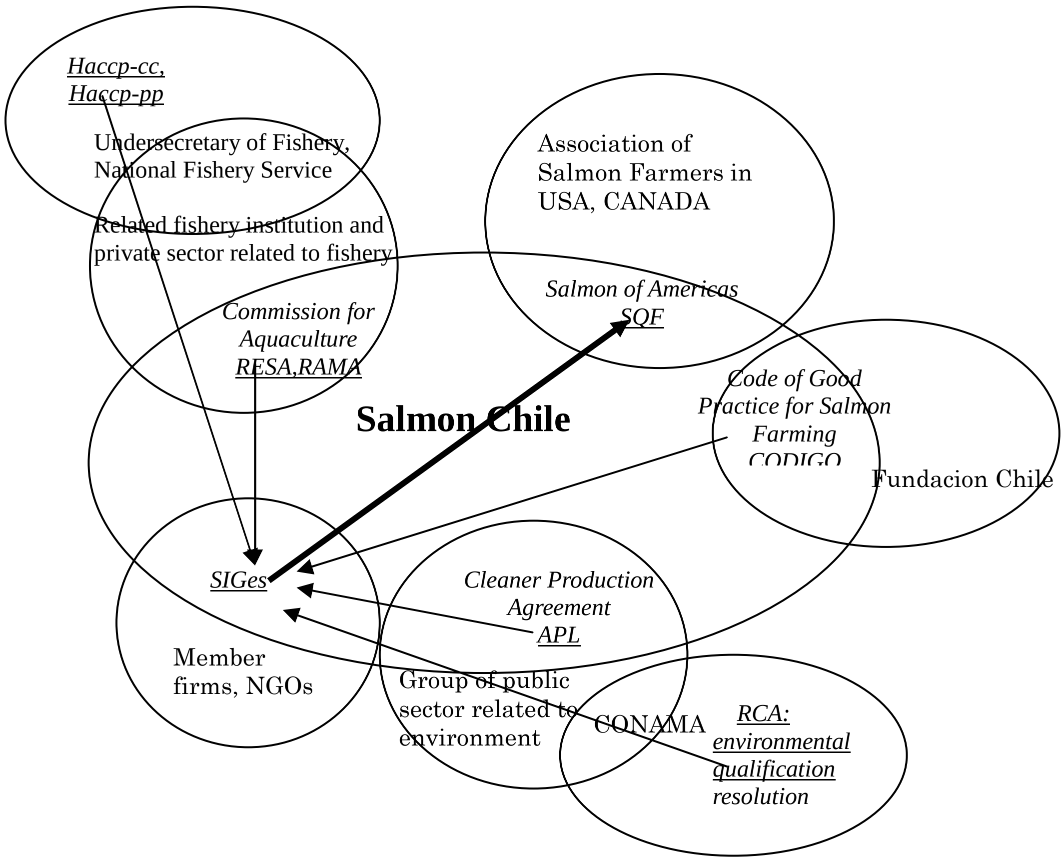

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

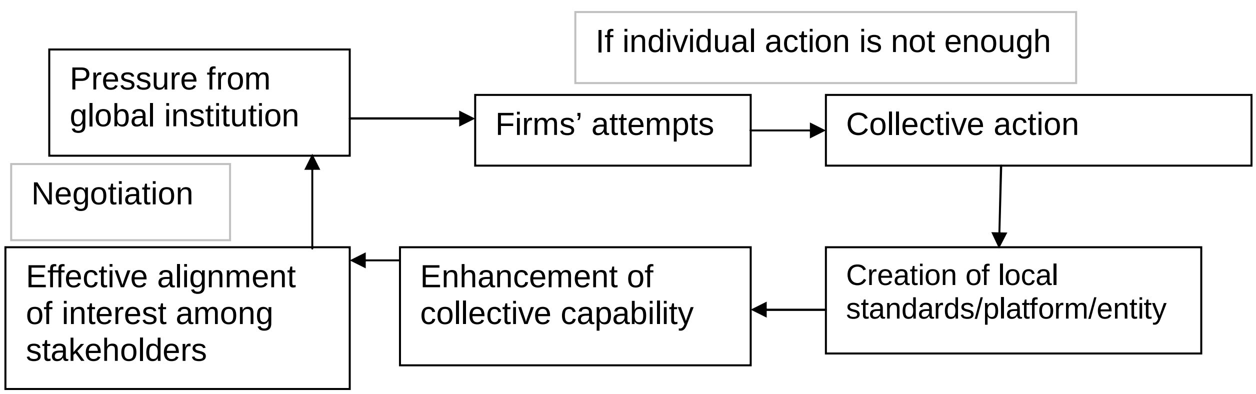

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

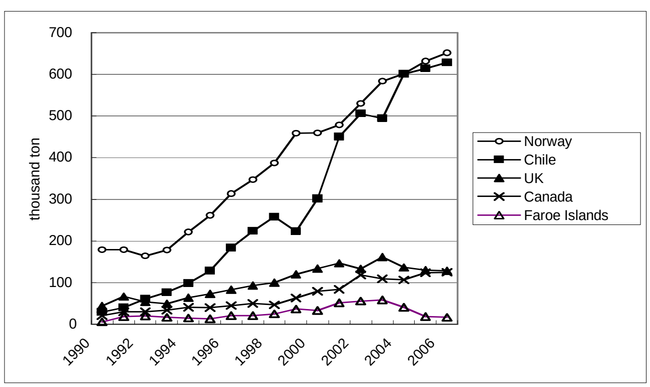

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

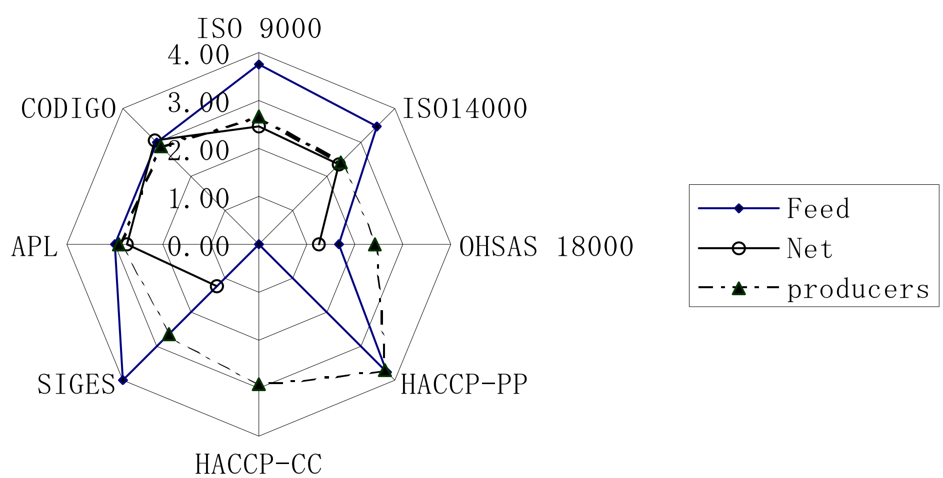

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

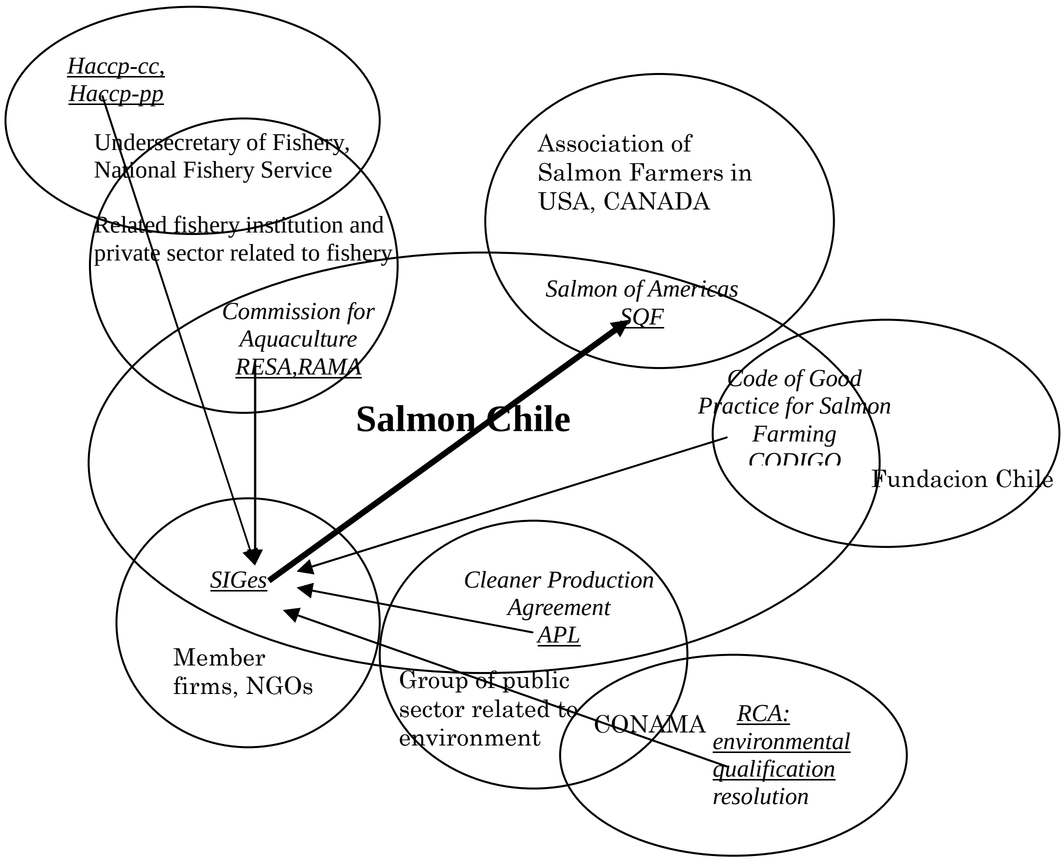

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

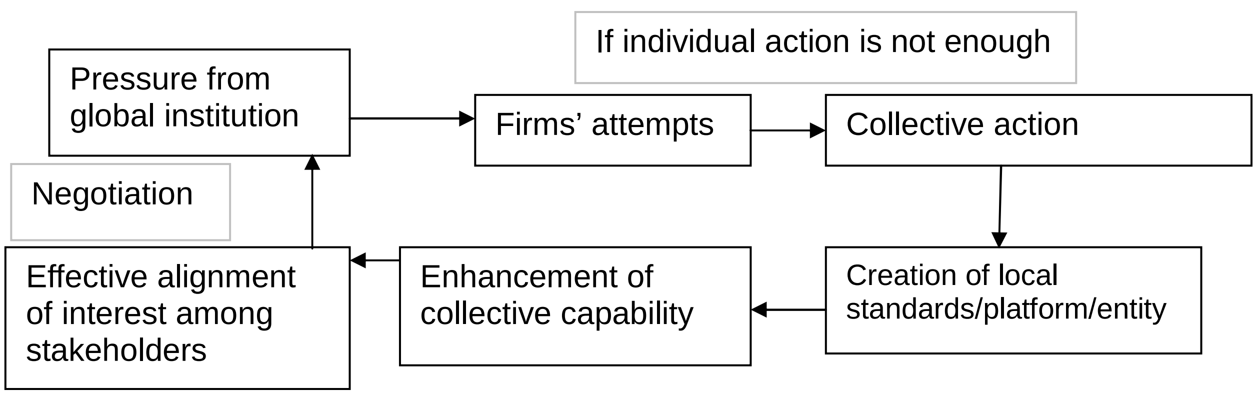

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

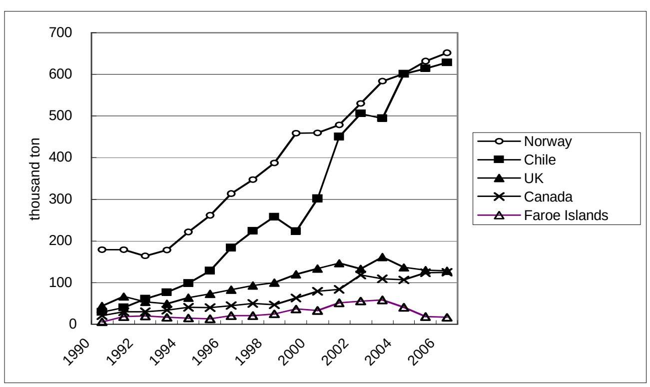

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

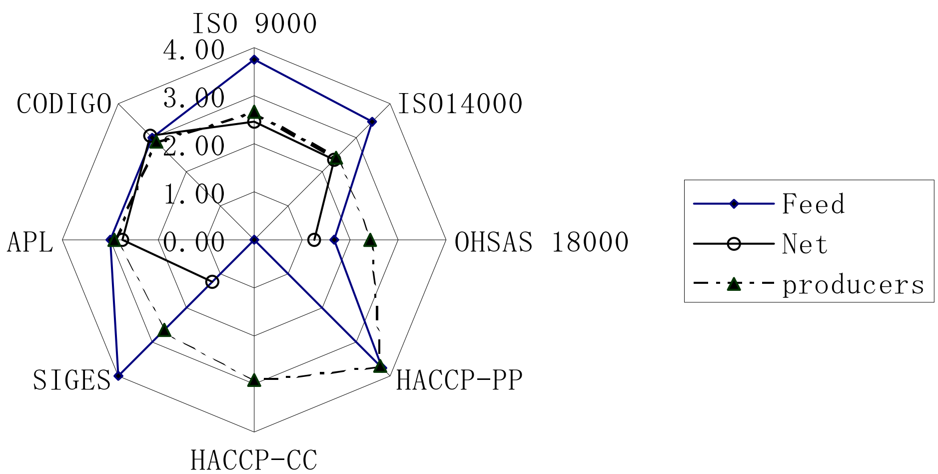

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were ‘EXPERIENCE’, ‘SALES’, ‘PROF’ and ‘ASOC’, for the standards compliance scores, ‘all’, ‘international’ and ‘local’. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, ‘SALES’ is a single variable that affects the higher compliance level, while for local standards, ‘PROF’ and ‘ASOC’ are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, ‘SALES’. It is, however, worth observing that firm-level technological capacity represented by ‘PROF’ and collective capacity represented by ‘ASOC’ are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

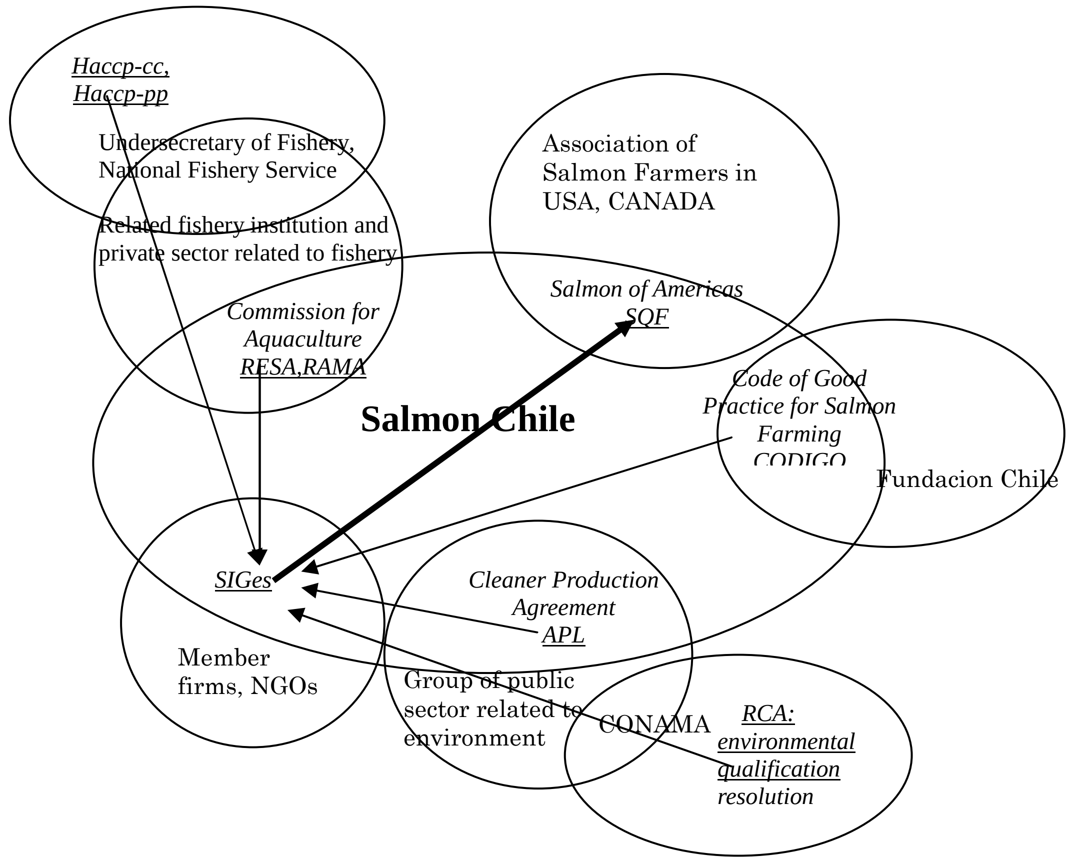

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

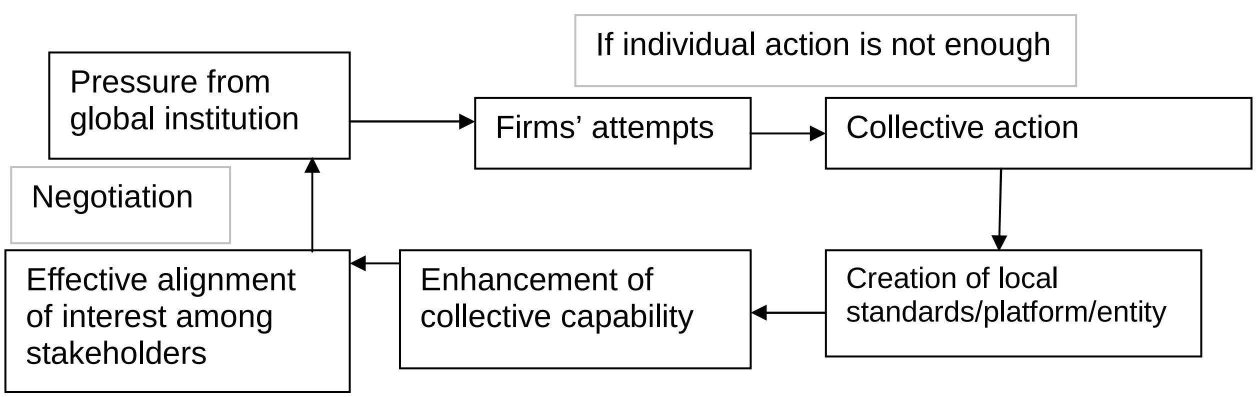

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

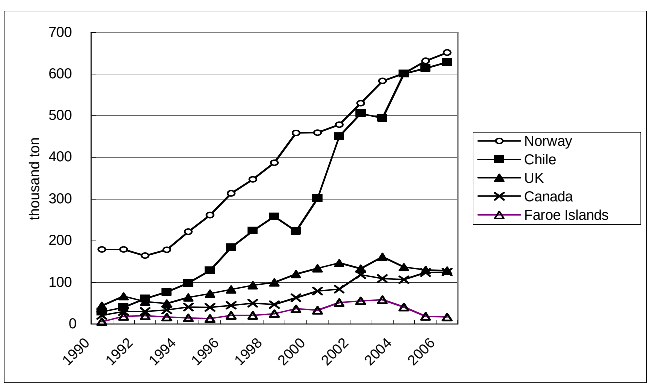

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

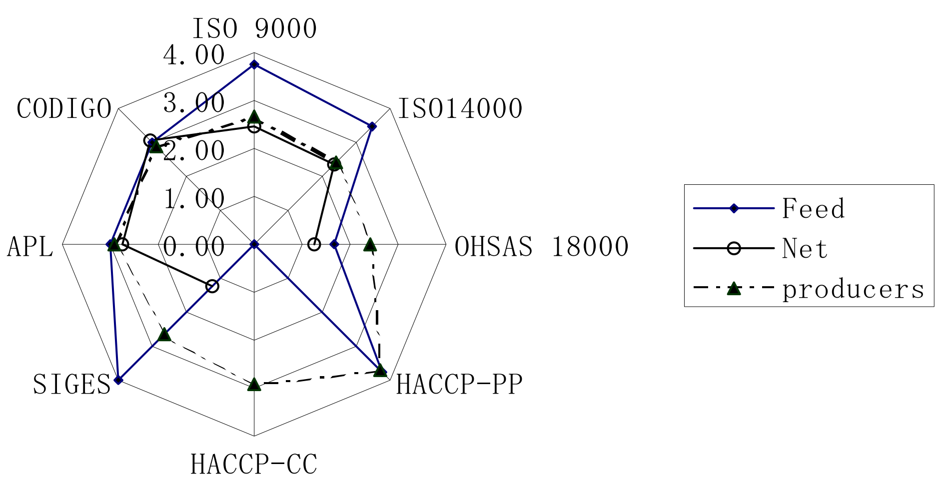

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the 'cleaner production initiative' which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the 'adaptation' and 'modernization' stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

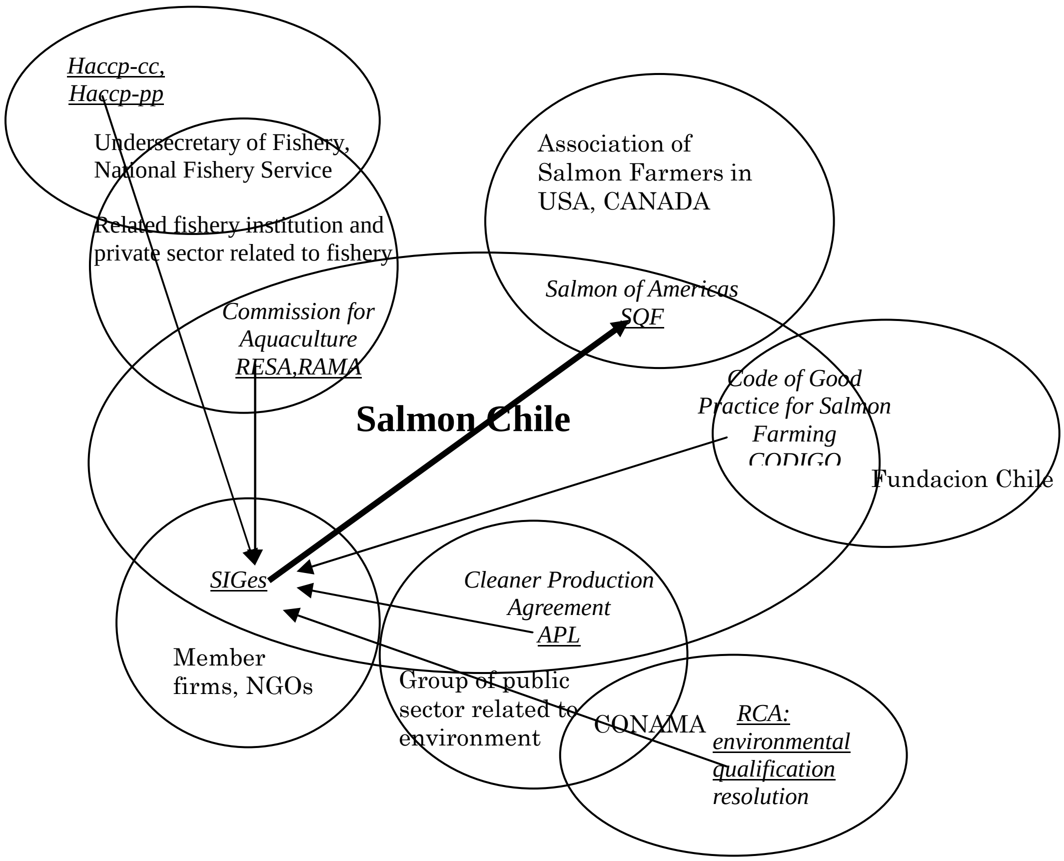

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

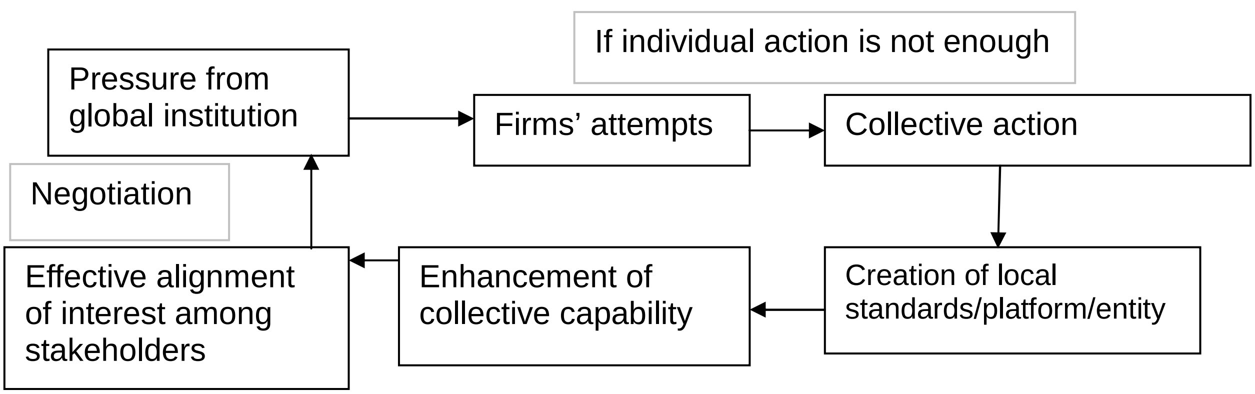

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

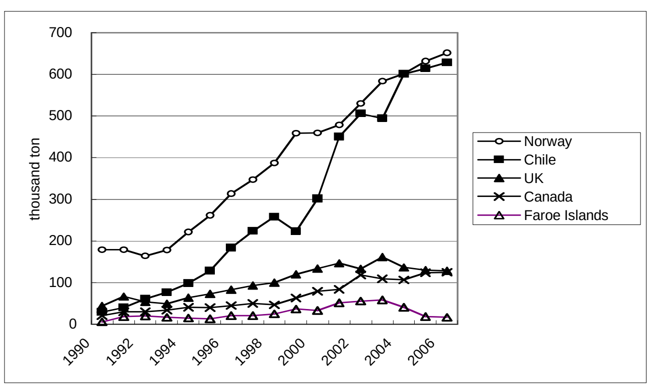

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

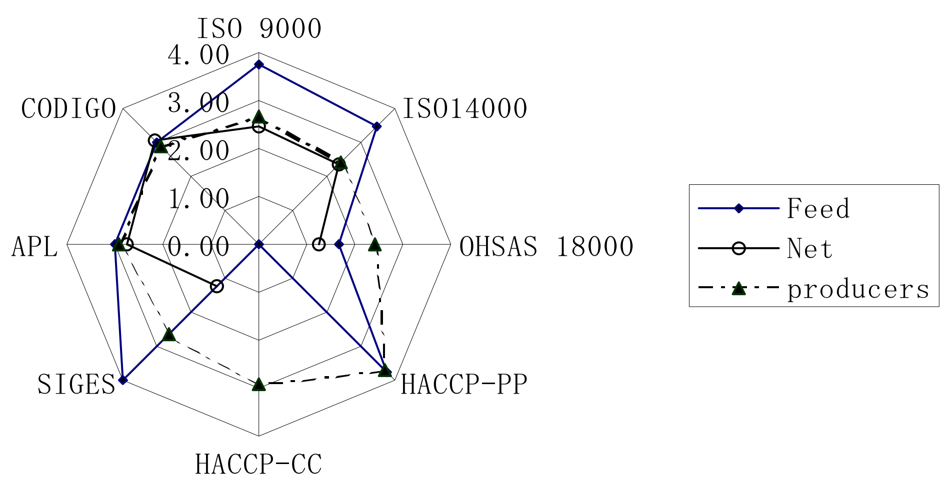

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

‘AGE’ is the firm’s total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

‘PROF’ expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable ‘SALES’ demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

‘ASOC’ is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

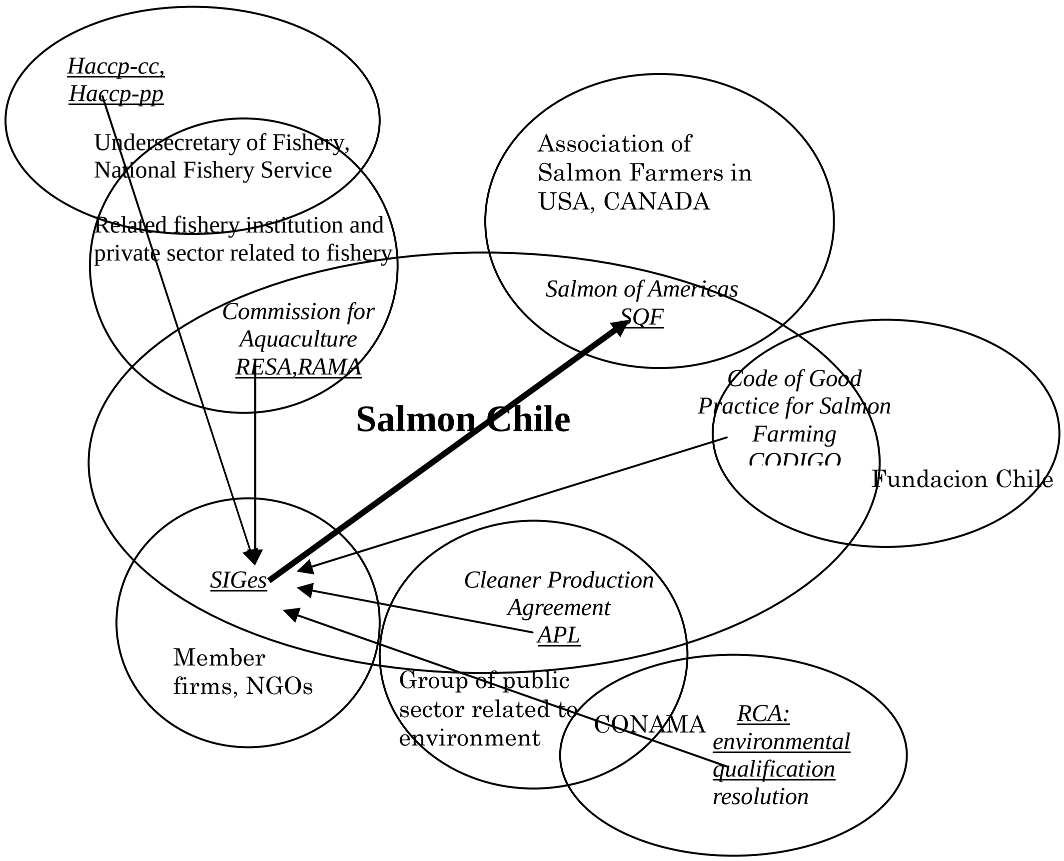

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

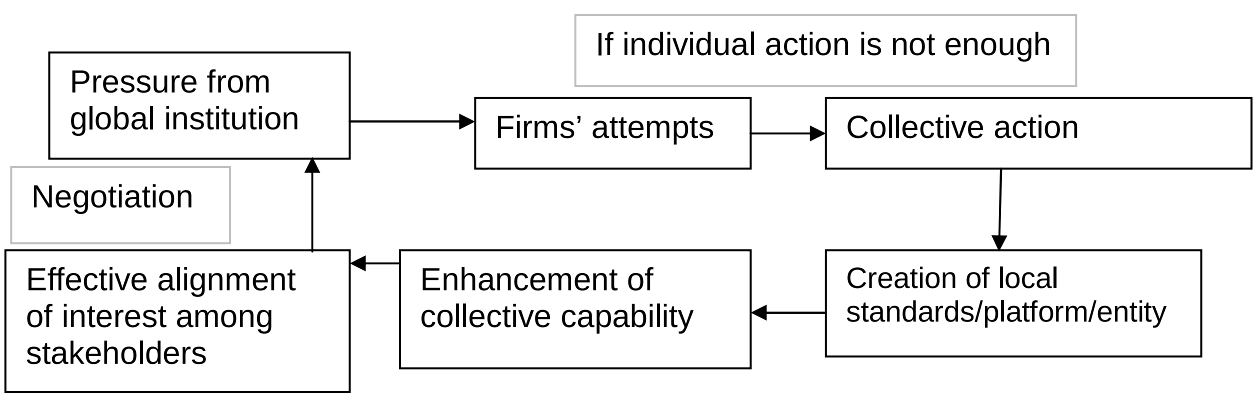

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

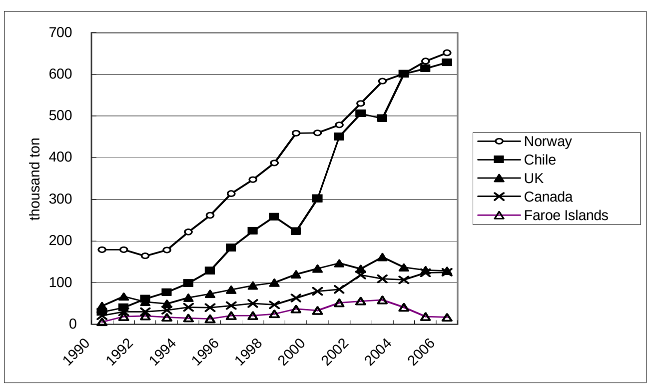

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

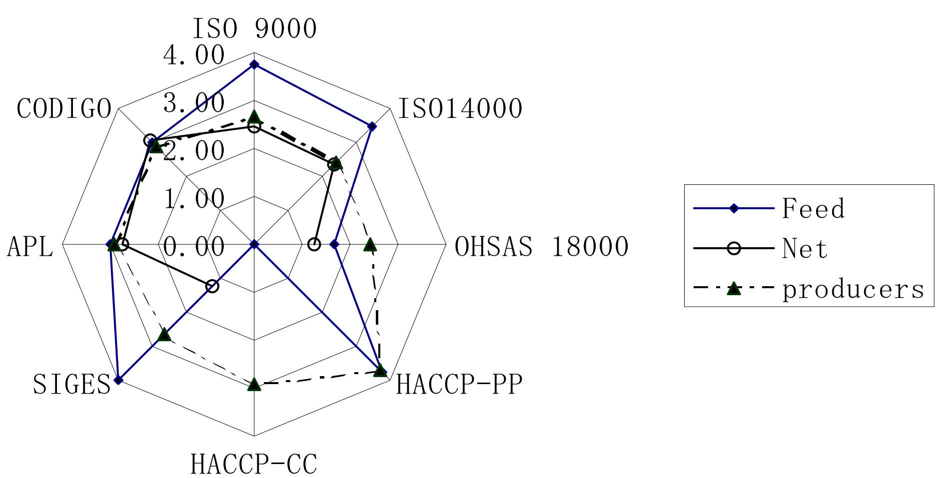

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

‘AGE’ is the firm’s total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

‘PROF’ expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable ‘SALES’ demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

‘ASOC’ is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were ‘EXPERIENCE’, ‘SALES’, ‘PROF’ and ‘ASOC’, for the standards compliance scores, ‘all’, ‘international’ and ‘local’. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, ‘SALES’ is a single variable that affects the higher compliance level, while for local standards, ‘PROF’ and ‘ASOC’ are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, ‘SALES’. It is, however, worth observing that firm-level technological capacity represented by ‘PROF’ and collective capacity represented by ‘ASOC’ are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

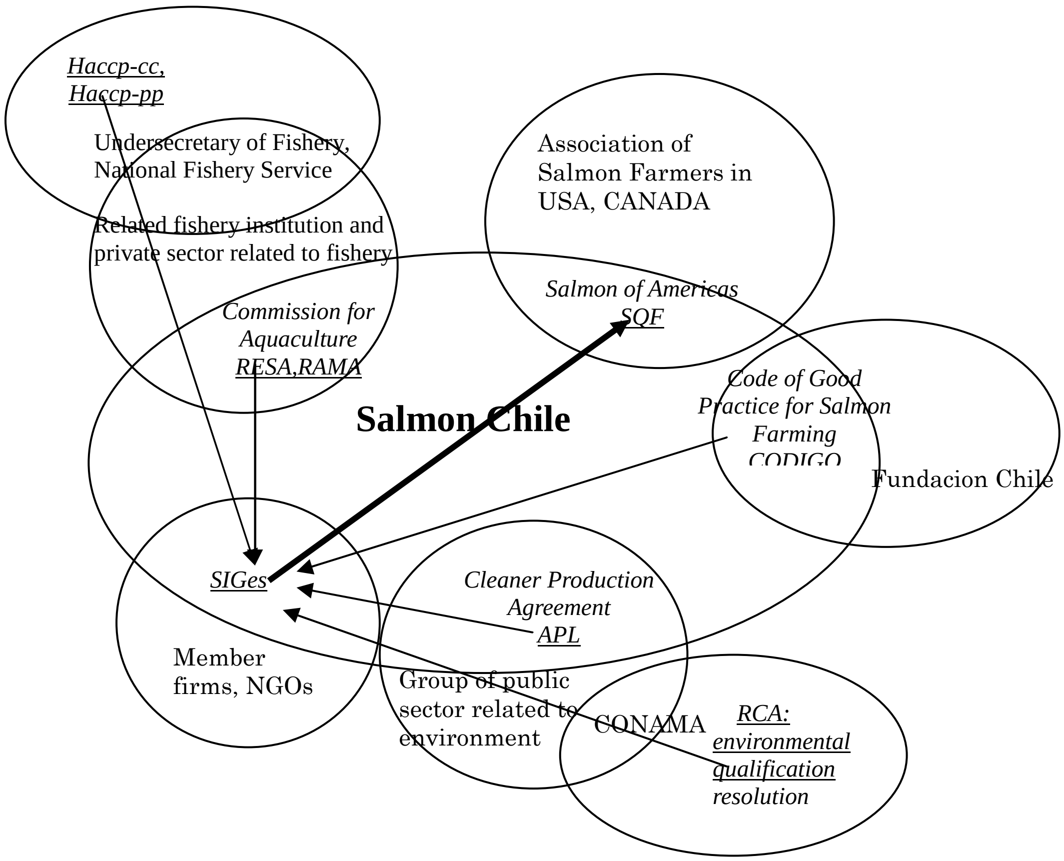

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

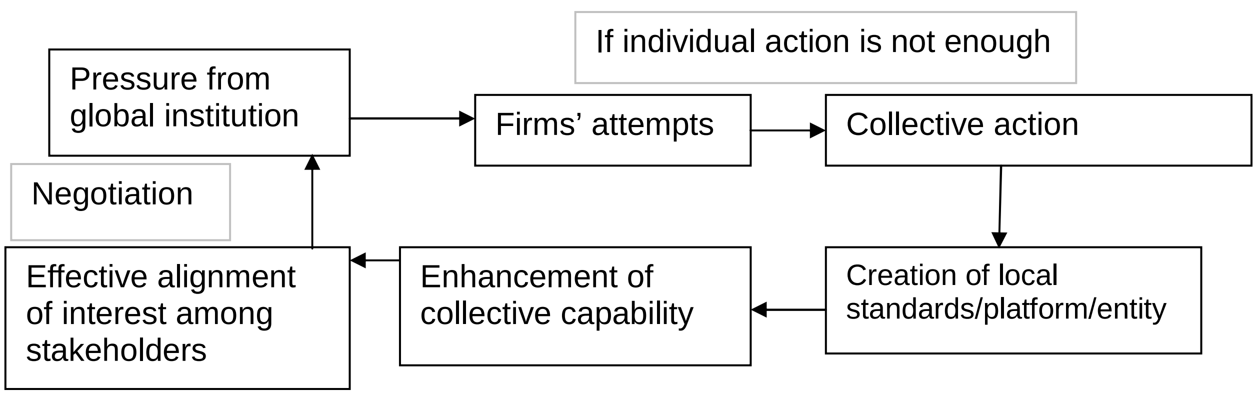

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

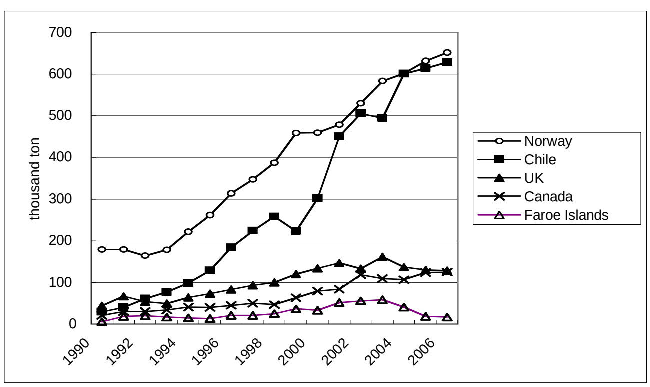

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

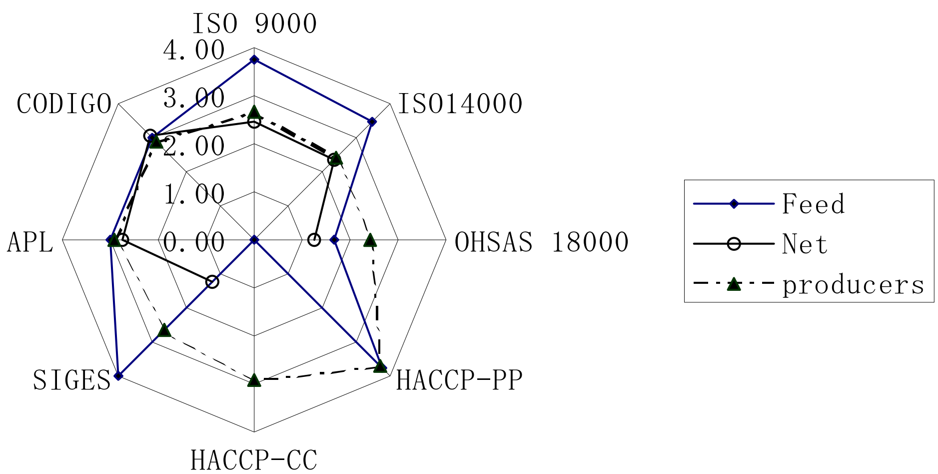

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

•**ISO 9000:**	A global standard for quality management
•**ISO 14000:**	A global standard for environmental management
•**OHSAS 18000:**	A global standard for occupational health and safety

Local standards: adapted versions of global standards

•**HACCP-CC:**	Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
•**HACCP-PP**:	Same as above but for the fish-meat processing plants.
•**APL:**	Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
•**SIGes**:	Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
•**CODIGO**:	Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were ‘EXPERIENCE’, ‘SALES’, ‘PROF’ and ‘ASOC’, for the standards compliance scores, ‘all’, ‘international’ and ‘local’. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, ‘SALES’ is a single variable that affects the higher compliance level, while for local standards, ‘PROF’ and ‘ASOC’ are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, ‘SALES’. It is, however, worth observing that firm-level technological capacity represented by ‘PROF’ and collective capacity represented by ‘ASOC’ are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

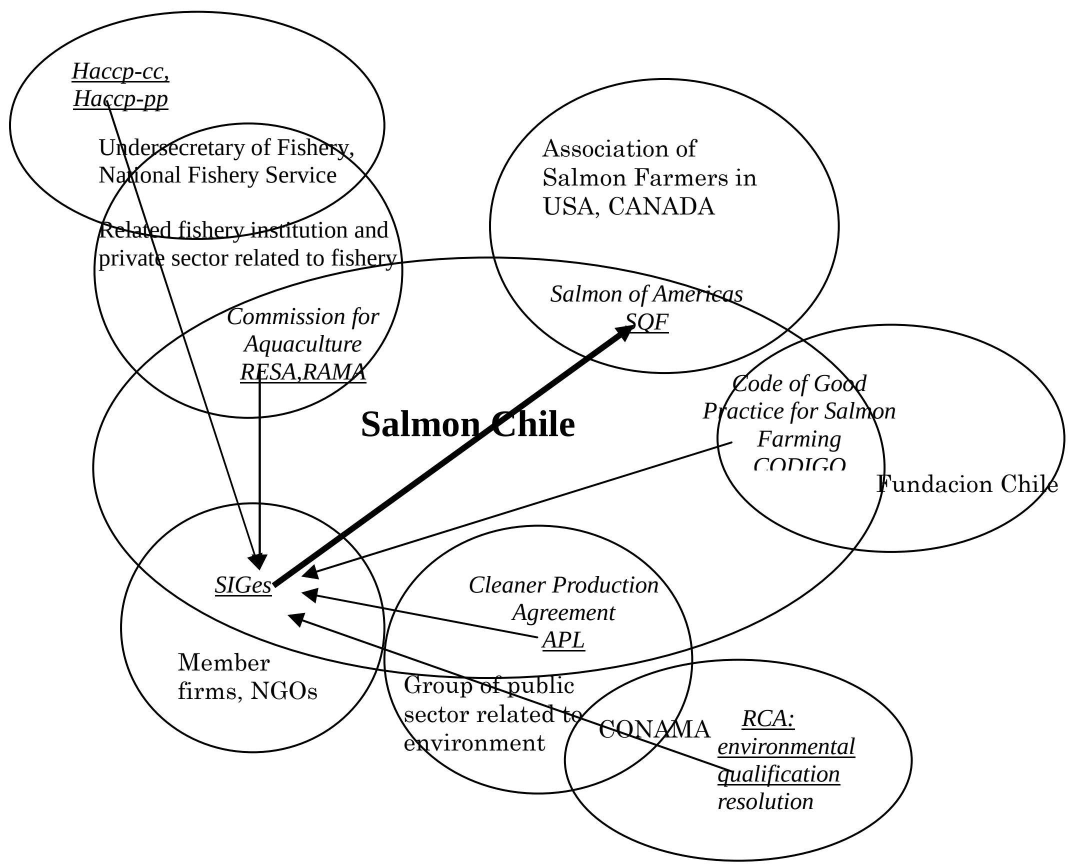

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA
Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

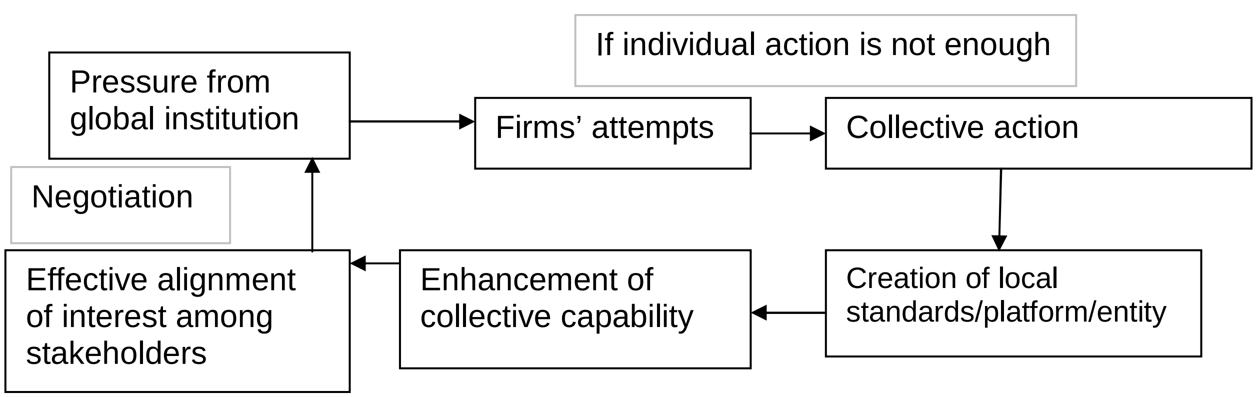

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

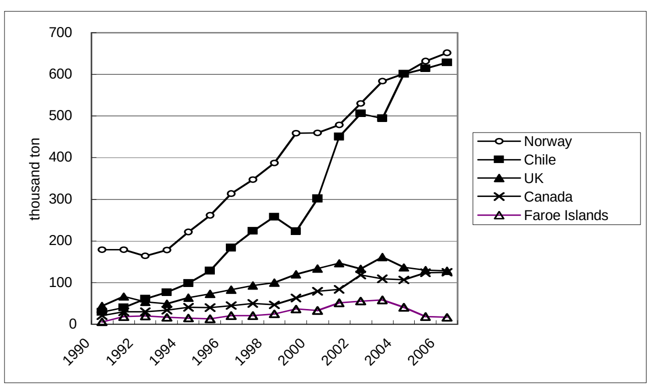

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

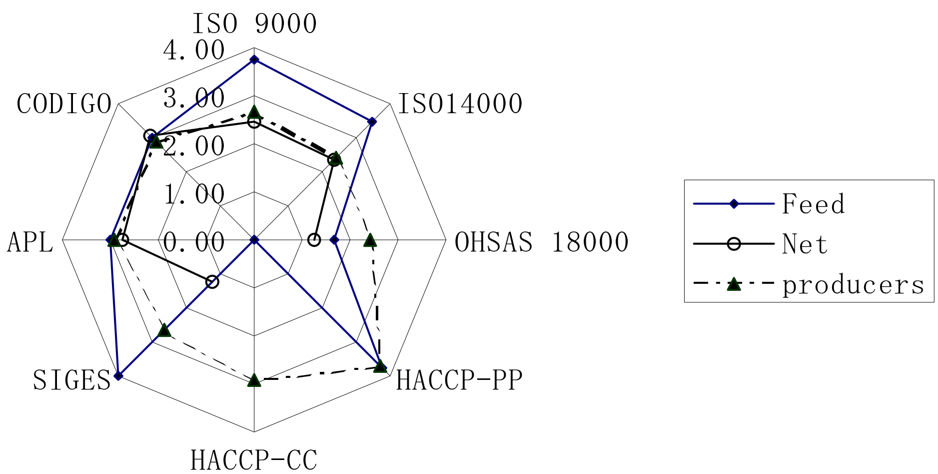

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

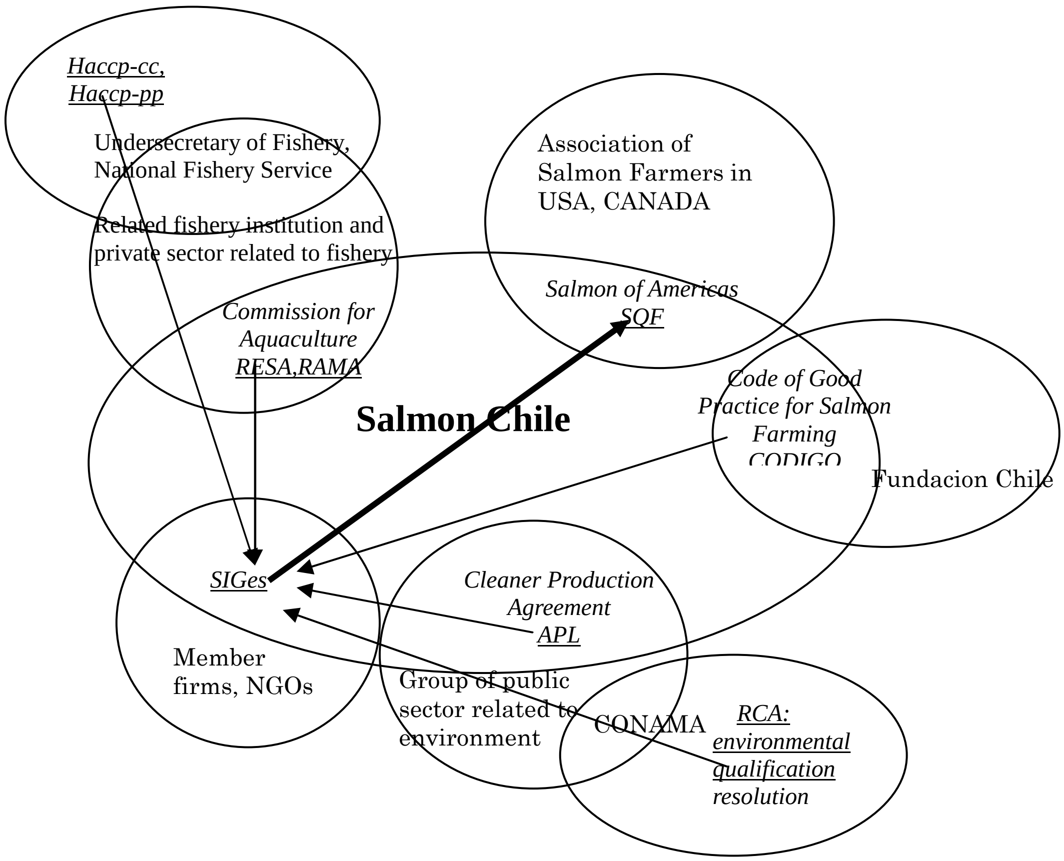

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

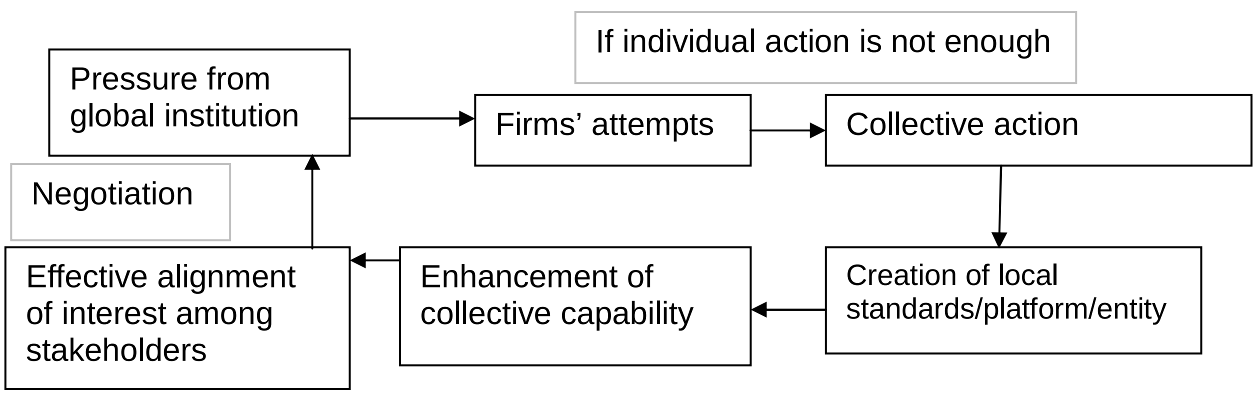

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

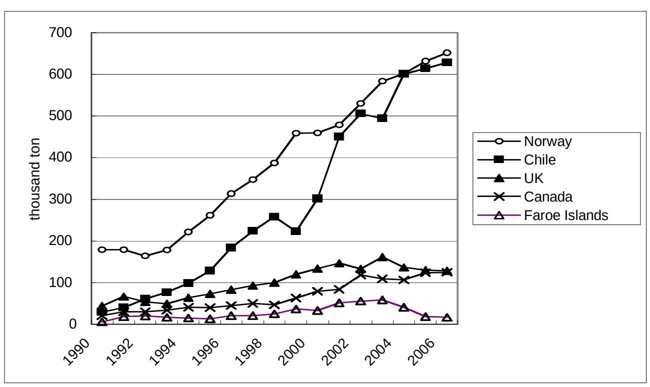

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

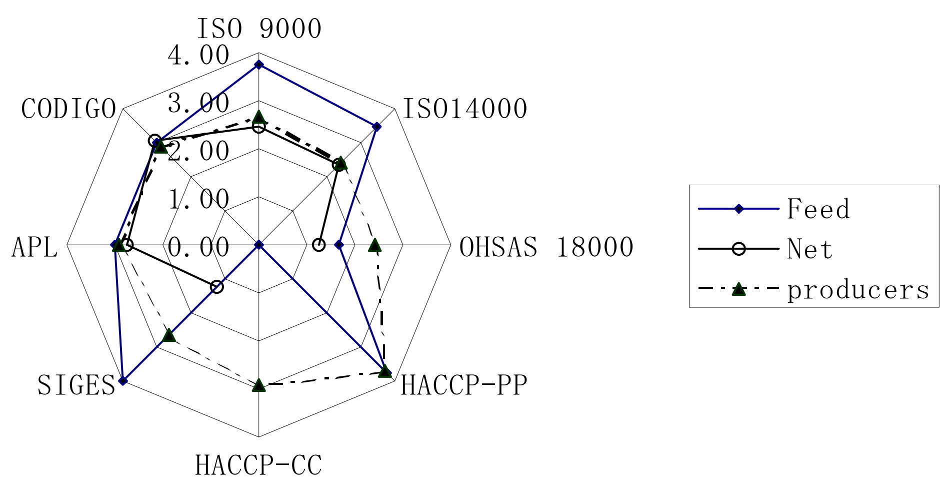

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience		Age	Sales		Prof		Association	
	N	Asymp.Sig		Asymp.Sig	Asymp.Sig		Asymp.Sig		Asymp.Sig	
ISO 9000	40	0.014	**	0.347	0.006	***	0.001	***	0.034	**
ISO 14000	41	0.032	**	0.131	0.006	***	0.004	***	0.007	***
OHSAS 18000	41	0.447		0.444	0.702		0.028	**	0.046	**
HACCP-PP	41	0.016	**	0.149	0.001	***	0.000	***	0.000	***
HACCP-CC	40	0.032	**	0.693	0.080	*	0.005	***	0.071	*
SIGes	41	0.331		0.870	0.129		0.007	***	0.317	
APL	41	0.023	**	0.405	0.052	*	0.002	***	0.057	*

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

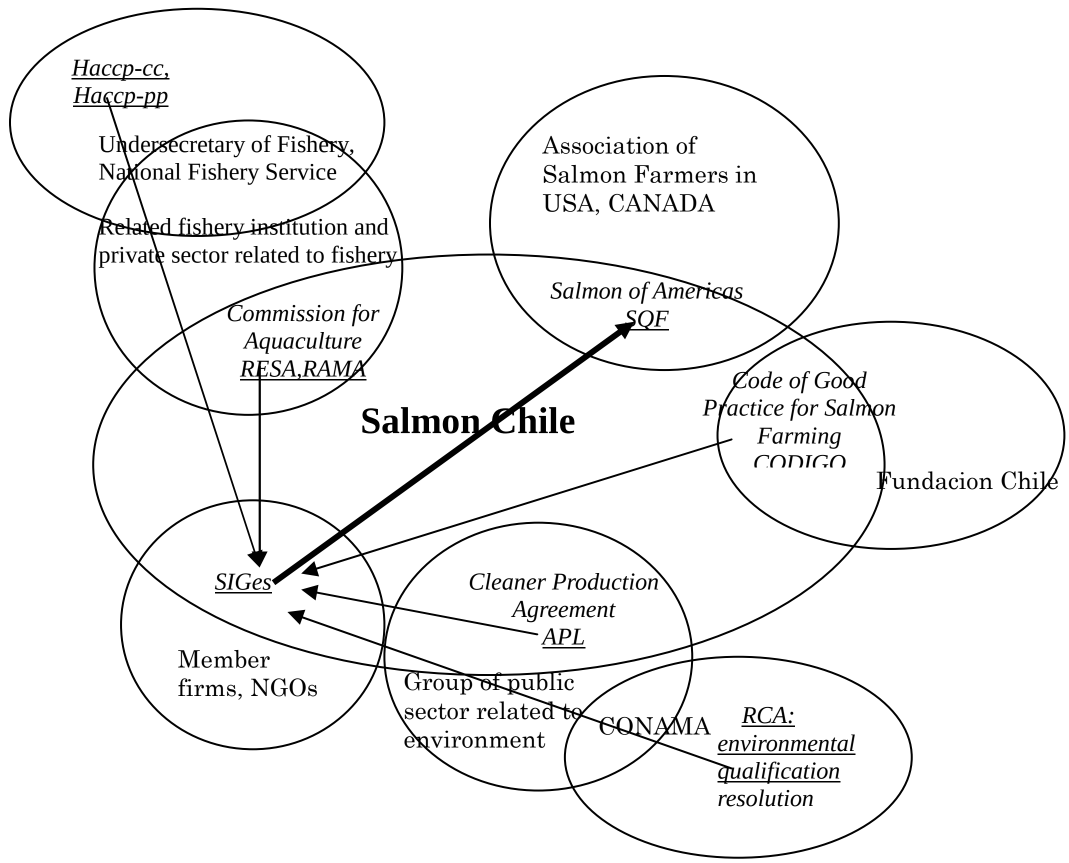

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

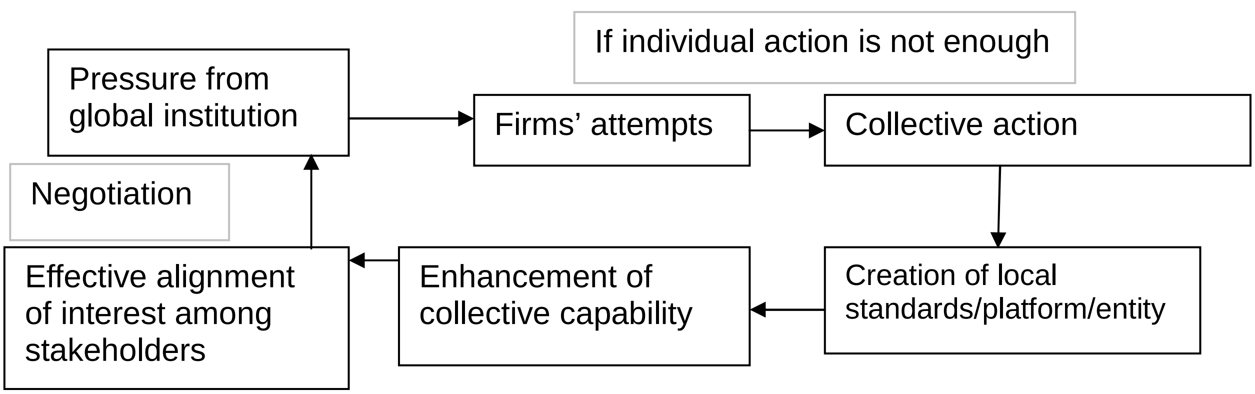

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are 'governed' by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through 'copying' and 'adapting' to the exogenously determined standards, then through 'imitating' and 'integrating'; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of 'countervailing power' has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple 'commodity trap' (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that "covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides" (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able "to address rapidly changing environments" (Teece, Pisano and Shuen, 2000: 516). Similarly, 'absorptive capacity' (Cohen and Levinthal, 1990: 128) identifies the "ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability." They claim that absorptive capacity is determined by the firm's prior related knowledge – often the prior investment in R&D.

In other words, 'capability' is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

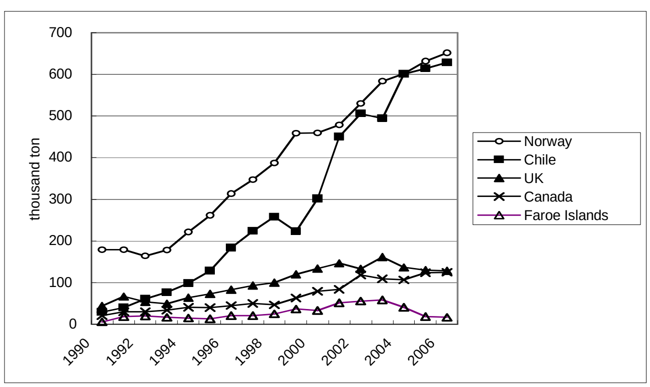

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

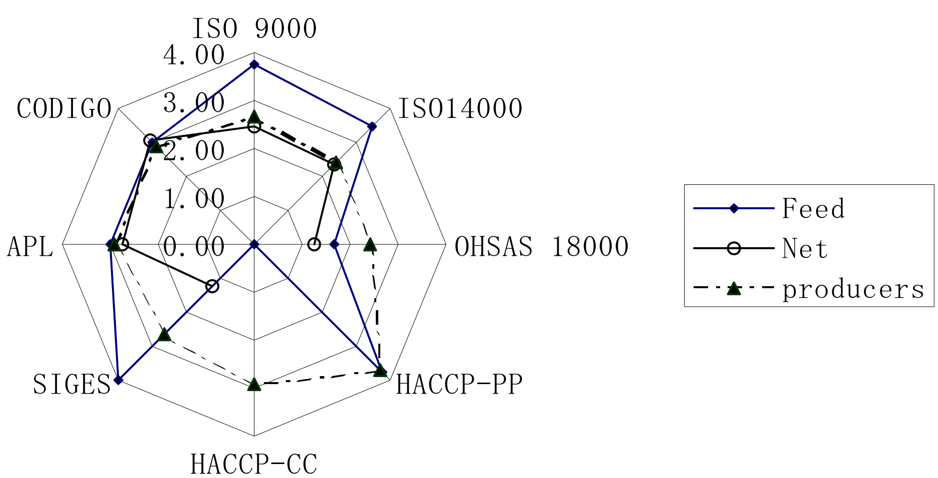

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called 'quality seal' (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association's 'quality seal' phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

‘AGE’ is the firm’s total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

‘PROF’ expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable ‘SALES’ demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

‘ASOC’ is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for 'PROF' and 'SALES' instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except 'AGE' had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for 'EXPERIENCE', 'PROF' and 'SALES'. The significance level is particularly strong for the variable for number of professionals. This means that the firm's own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, 'ASOC'. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

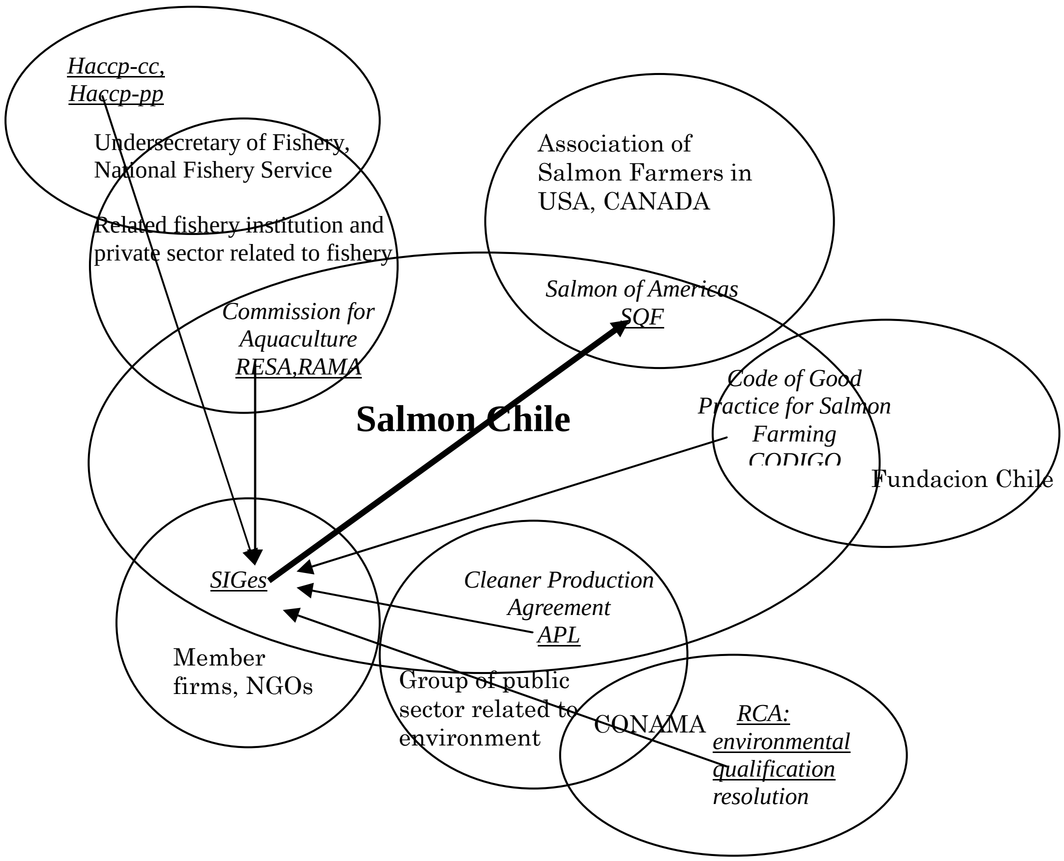

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

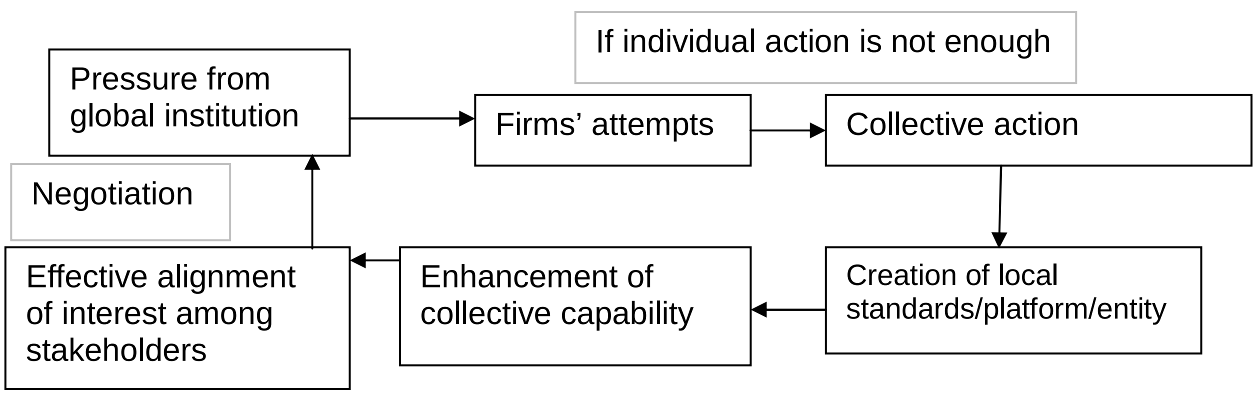

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are 'governed' by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through 'copying' and 'adapting' to the exogenously determined standards, then through 'imitating' and 'integrating'; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of 'countervailing power' has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple 'commodity trap' (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that "covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides" (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able "to address rapidly changing environments" (Teece, Pisano and Shuen, 2000: 516). Similarly, 'absorptive capacity' (Cohen and Levinthal, 1990: 128) identifies the "ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability." They claim that absorptive capacity is determined by the firm's prior related knowledge – often the prior investment in R&D.

In other words, 'capability' is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

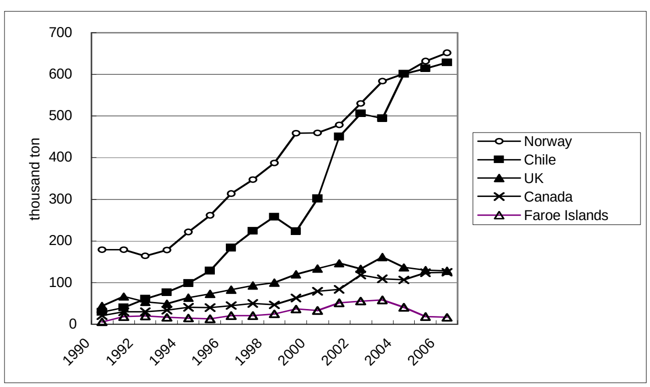

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

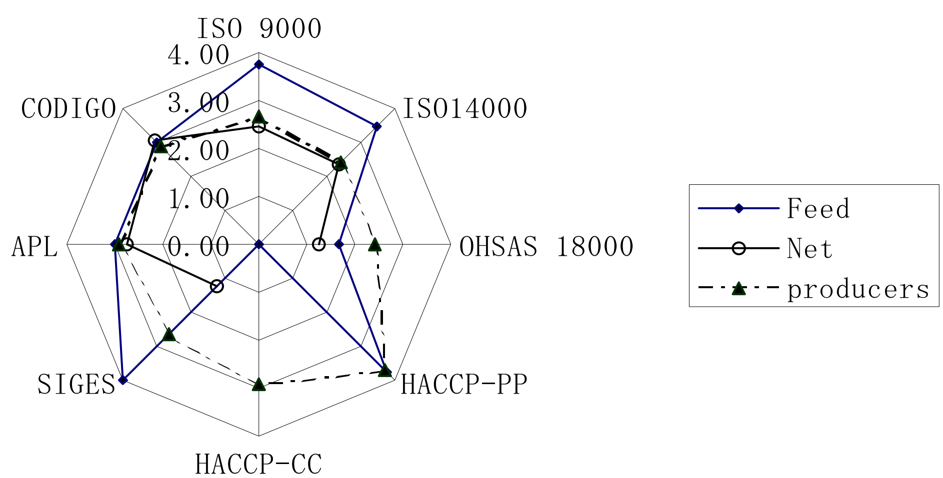

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the 'cleaner production initiative' which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the 'adaptation' and 'modernization' stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed 'collective capability'.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: 'EXPERIENCE' (past experience of participation), 'AGE' (firm age), 'SALES' (size), 'PROF' (number of professionals), 'ASOC' (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm's capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

'EXPERIENCE' demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

'AGE' is the firm's total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

'PROF' expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable 'SALES' demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

'ASOC' is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience	Age	Sales	Prof	Association
	N	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig	Asymp.Sig
ISO 9000	40	0.014 **	0.347	0.006 ***	0.001 ***	0.034 **
ISO 14000	41	0.032 **	0.131	0.006 ***	0.004 ***	0.007 ***
OHSAS 18000	41	0.447	0.444	0.702	0.028 **	0.046 **
HACCP-PP	41	0.016 **	0.149	0.001 ***	0.000 ***	0.000 ***
HACCP-CC	40	0.032 **	0.693	0.080 *	0.005 ***	0.071 *
SIGes	41	0.331	0.870	0.129	0.007 ***	0.317
APL	41	0.023 **	0.405	0.052 *	0.002 ***	0.057 *

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

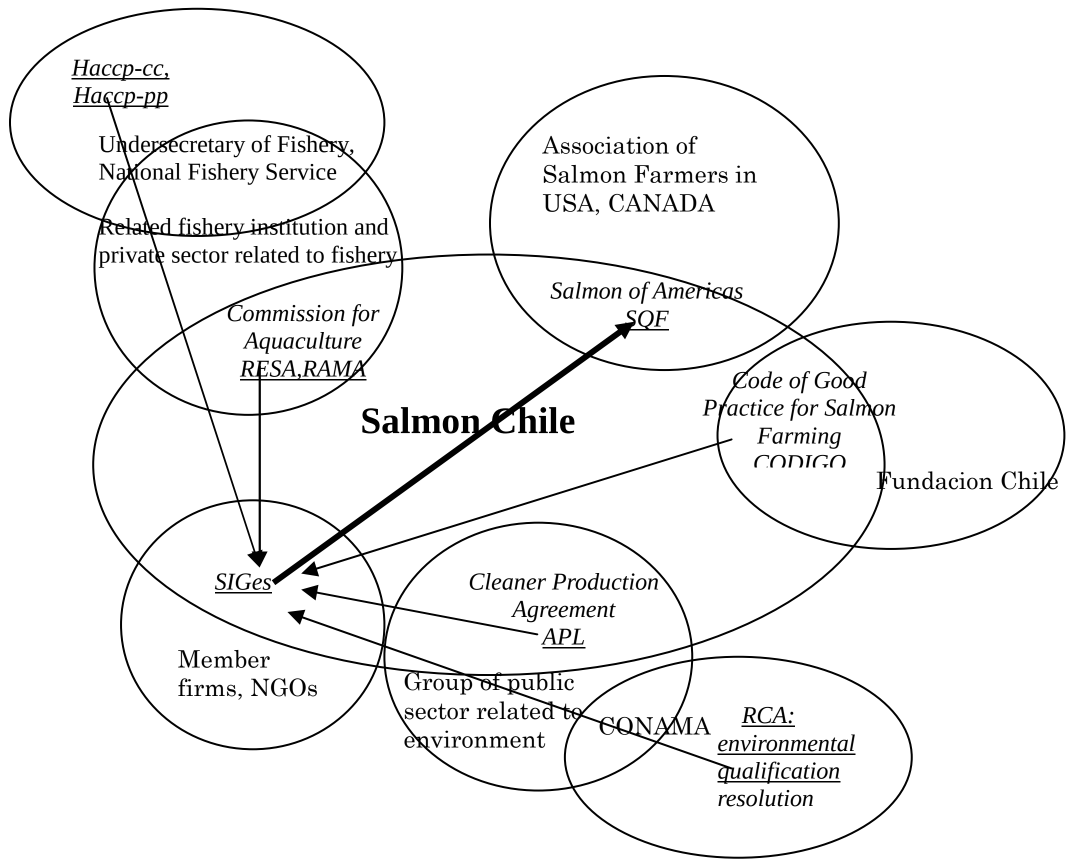

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

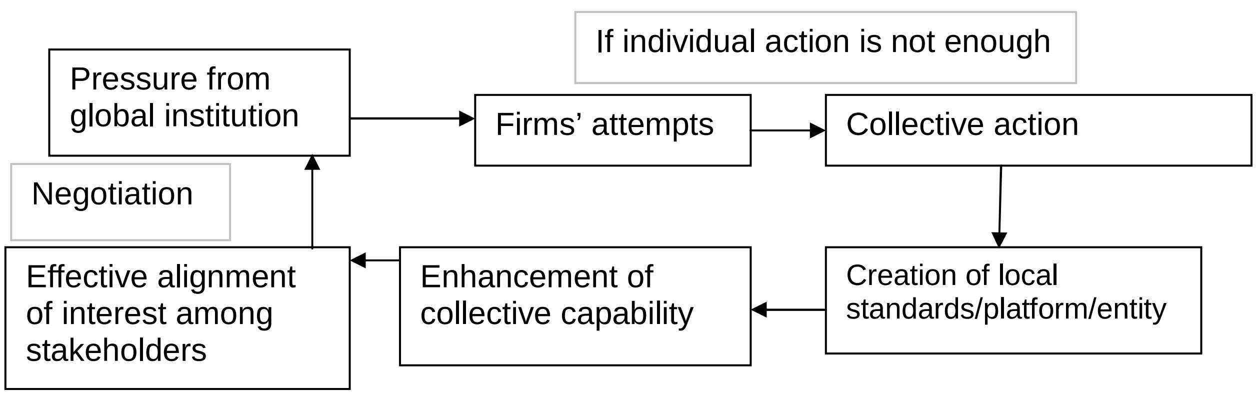

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Standards as a platform for innovation and learning in the global economy: a case study of Chilean salmon farming industry

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Abstract

Conventionally, standards are considered as a governance tool in the production system in a one-directional and hierarchical relationship between foreign trans-national corporations (TNCs) or global buyers on one hand and subsidiaries and producers on the other. They were considered as transmitting necessary specifications of goods – codified knowledge – to the producers. Despite the fact that this process begins with a one-way power relationship and associated flow of knowledge and standards, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of collective capability in catching-up countries. In such a context, standards increasingly act as a catalyst for creating collective interfaces where diverse knowledge from horizontal and vertical relationships – local and global, tacit and codified, and buyer and producer – intercept and converge to promote interactions and learning for those involved. The Chilean salmon farming industry is examined to understand how standards compliance enhanced collective capability.

Key words
Standards, Capability, Governance, Catching up

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1. Introduction

Present-day economic globalization is increasingly accompanied by complexity in innovation processes. Recent studies on Transnational corporations (TNCs) (Birkinshaw and Hood, 1998; Cantwell and Iammarino, 2003) as well as Global Production Networks (Ernst, 2001; Borrus et al., 2000) have illustrated how today's innovation process has become transformed into multi-stakeholder activity. Such change is a reflection of realities in current global innovation, which is increasingly: faster in the speed of creation and deterioration, less linear in creation from knowledge to diffusion (Amesse and Cohendet, 2001), and more reliant on the capacity to systematically exploit existing knowledge by constructing new uses and devising fresh combinations (Teubal et al., 1996). In such a complex and changing world, innovation would require 'organizational capability', or orchestrating collective actions with various stakeholders participating, to complement their own specialized routines (Levinthal, 2000), to create and manage knowledge effectively. Henderson and Clark (1990) similarly observe that there is 'architectural innovation' in addition to conventional 'incremental' and 'radical' innovation. In other words, innovation in a globalizing economy involves not just incrementing firm-level capability but also an ability to formulate collective action. To do so, a common platform and institution in which management of such platforms are required so that multiple stakeholders can communicate; bringing in existing knowledge in negotiating, collaborating and integrating to establish the future direction of innovation.

In a globalizing economy, the use of standards, as a codified form of knowledge, has increased, as they allow interaction and facilitate diffusion through conformity between or among institutions at 'arm's length'. Due to this particular character of standards, they have been used as a good management tool in global networks of production and increasingly come into use on a de-facto basis, regulated by market mechanisms without much state intervention (Cutler et al., 1999; Finger and Tamiotti, 1999; Nadvi and Waltring, 2003; Clapp, 1998).

Increased use of standards brings mixed blessings for developing countries. While the adoption of private standards facilitates the access to market and certain kinds of knowledge such as "know-what" – using the term by Johnson, Lorenz and Lundvall (2002) – it does not automatically lead to access to other kinds of knowledge such as "know-why" and "know-how", let alone "know-who", to facilitate achieving actual compliance. In other words, standards transmit to these countries some knowledge of 'what' they need to do but not necessarily accompany this with the knowledge of 'how' to achieve it. Due to such partiality, prevalent use of standards can actually set up dominant forces that shape standards in such a way as to 'govern' disadvantaged ones (David and Steinmueller, 1994). In fact, Clapp (1998), based on the case of ISO14000, claimed that implementation of such private-led standards can be disadvantageous to developing countries, which lack the financial and political power for effectively influencing the determination of the contents of the standards.

This paper attempts to bring out an extensive and endogenous role of standards, as an opportunity to build platforms of collaboration among stakeholders especially in catching-up countries, in their processes of compliance via local-

global interactions; rather than seeing them as merely an instrument for transmission of codified knowledge and governance.

The paper examines the capabilities required for a firm to comply with the standards, using the case of the Chilean salmon farming industry. This is an industry which experienced unusually successful development to world leadership in a premium natural-resource based product through catching up. For firms to enter the global market in this activity, it was necessary to comply with global standards. The case study demonstrates that compliance with the standards reflects the individual firm's capacity to do so but also the collective capacity. The result suggests that standards compliance, in the given circumstances, can help to form an effective platform for collaboration in catching-up countries to be successful at competing in the global economy.

2. Theoretical background

2.1 Role of standards

In general, standards support both conformity and diversity: they act as "external points of reference" (Hawkins et al., 1995: 1) for assessing the performance, quality and physical characteristics of products or services. This role of assurance is essential in promoting the exchange of commodities on a global scale. Swann (1999: 12) identifies four broad types of functions performed by standards that have important implications for the economy. These are: (1) defining interfaces and compatibility; (2) attaining minimum quality; (3) achieving reduction of variety; and (4) establishing standards of information and production description.

Swann's definition opens up a much wider role for standards than a mere 'reference point'. Antonelli (1998) elaborates Swann's functions based on economic perspectives in a policy-oriented context. First, standards can substitute for regulatory interventions that stimulate competition. For instance, mandatory standards can be designed to direct firms towards more innovative activities than staying in small niche markets. Second, standards can play a major role in making explicit the tacit and localized knowledge on which new products and manufacturing processing are based. Furthermore, this knowledge management of going back and forth between 'codified' and 'tacit' forms of knowledge at global and local level would facilitate the exchange of knowledge and spillover of externalities in the economic system, and in particular, enhance innovation capabilities.

Despite the fact that use of standards may support diffusion and exchange of knowledge, some argue that the conversion process between tacit and codified knowledge is more complex (Johnson, Lorenz and Lundvall, 2002). Their study claims that codified-tacit distinction may not fully describe the complexity of knowledge. They distinguish knowledge into four categories: 'know what', 'know why', 'know how' and 'know who', and assert that the first two represent the 'codified' knowledge on 'facts' and 'principles and laws of motion in nature', respectively, and that real application of such knowledge in use would require the latter two different types of tacit knowledge, 'skills obtained from experience' and 'knowledge of whom to ask for what', respectively. They particularly emphasise the importance of 'know-who' since network-based production requires how to combine

available ‘know-how’ with the knowledge of ‘know who’. Their argument suggests that for standards, to comply successfully with the ‘know what’, needs complementary but different types of knowledge that are not confined to the firm but extend much beyond it.

Antonelli (1998) considers standards as a dynamic institution. He defines standards as non-pure private goods, formulated by the stakeholders in markets as the result of agreeing on the most efficient form of solution by evaluating adoption and elaboration (or sponsoring) costs. As both costs differ greatly in respect of the externality gained from the number of participants who share the same standards, the decision-making process requires knowledge of decisions taken by others (Cabral, 2000). Forey (1994), based on Schelling’s model of coalitions in social behaviour, also shows standards are not an individual decision but require collective action in more organized structures, such as forming coalitions. The above descriptions of standards coincides with the previous argument made by Johnson, Lorenz and Lundvall (2002) that in the standards compliance process, ‘know how’ – here the skills to comply – and particularly ‘know who’ – the social ability to cooperate and communicate with different kinds of people and experts – become important. This argument identifies the particular feature of standards compliance which requires not only the appropriate technical knowledge by the individual firm but also the knowledge of other stakeholders.

2.2 Governance of standards: from the perspective of developing countries

In general, discussions on standards compliance take place in the situation where all the stakeholders are on relatively equal grounds, in developed nations. In a context of a developed/developing country relationship, the situation would be different.

In governance structure – the collective decision-making process (von Tunzelmann, 2003; Rhodes, 1996; Stoker, 1998) – developing countries often have a lesser role in influencing the rule-setting process due to lack of capabilities, as stated by Clapp (1998). The difficulties of acquiring capabilities – particularly the technological – in developing countries have been widely discussed in the past (e.g. Lall, 1992; Bell and Pavitt, 1993; Kim, 1998). Recent studies of globalization and the global division of knowledge creation (Lundvall and Johnson, 1994; Cantwell and Iammarino, 2003; Ernst, 2001) add yet another dimension through emphasising the differences in the way knowledge is created. These studies allocate a greater importance to local capability in knowledge creation and require different competences in developing countries so that knowledge flows are both ‘bottom up’ and ‘top-down’ (Iammarino, 2005). However, in developing countries, due to the lack of institutional capacity or ‘countervailing power’ as stated by Myint (1954), such reversal of knowledge flows has not often been observed.

Hence, despite globalization bringing rule-setting inside the collective decision-making process (Cutler, Haufler and Porters, 1999; Vandergeest, 2007; Clapp, 1998; Nadvi and Waltring, 2003), developing countries equipped with less knowledge are often excluded. When these developing countries take part in a global production network, standards are already exogenously determined by the dominant players, and they have no choice but to adapt to the existing

regime. In other words, the majority of producers in developing countries are ‘governed’ by developed countries in terms of standards and rule setting. However, it is possible to consider that enhancement of collective capability to participate in rule setting may take place through interaction with global players: first by complying through ‘copying’ and ‘adapting’ to the exogenously determined standards, then through ‘imitating’ and ‘integrating’; hence resembling very much the process of technological acquisition as described in the OEM-ODM-OBM model for the manufacturing sector in Asia (Hobday, 1995). Nevertheless, the paucity of studies that have looked at the collective capability of influencing standards though the importance of ‘countervailing power’ has long been recognized in development studies (Myint, 1954).

The focus on standards is also particularly relevant for the producers of agricultural and food products in the global market – such as the case studied here – where differentiation and branding of their produce through standards compliance could determine the competitive edge (Ponte, 2002; Vandergeest, 2007), as well as preventing these products falling into a simple ‘commodity trap’ (Singer, 1950; Prebisch, 1962; Kaplinsky and Fitter, 2004).

2.3 Types of capabilities in catching-up processes

The concept of capability addresses different – often overlapping and interrelated – abilities at distinctive levels. Organizational capability is considered as a relational asset, a routine, among the skills or resources that firms possess (Nelson and Winter, 1982). Among such organizational capabilities, those enhancing learning and performance in organizations are considered as knowledge management (KM) that “covers any intentional and systemic process or practice of acquiring, capturing, sharing and using knowledge wherever it resides” (Foray, 2003). In a present-day context, such capability also needs to be dynamic, able “to address rapidly changing environments” (Teece, Pisano and Shuen, 2000: 516). Similarly, ‘absorptive capacity’ (Cohen and Levinthal, 1990: 128) identifies the “ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends as the important capability.” They claim that absorptive capacity is determined by the firm’s prior related knowledge – often the prior investment in R&D.

In other words, ‘capability’ is generally a collective design and specialization of individual skills in co-evolutionary form. The only difference from this that the case of standards compliance and establishment has is that its focus on knowledge management in collective form does not aim to identify the complementary new skills and knowledge among stakeholders, but create common platforms or consensus through combining externally available knowledge. This shares some similarity with the Nonaka and Takeuchi (1995) notion of organizational knowledge creation, in which knowledge is created in spiral form as it transcends epistemological and ontological dimensions. Nevertheless, the case of standards can be extended still further to include stakeholders beyond the firm level. In this respect, it may also have similarity with the capability that resides in networks, at both geographical as well as relational levels (Saxenian, 1994; Powell et al., 1996); however, there is a difference in the way the aim is directed and achieved for collective common benefit, through creating a platform for all.

The case of standards setting and compliance hence presents a unique example of collective capability. This involves knowledge management residing not in relational form but in collective form, in search of new paths to solve emerging problems. The overall aim is to create or comply with standards because some benefits cannot be achieved by a single firm – such as creating products from certain geographical areas, enhancing and evaluating capabilities of adequate providers of products and services with cost effectiveness, maintaining environmental reputation of production sites, etc.

This paper observes the standards setting and compliance processes as a case of establishing collective capability by looking at the salmon farming industry in a catching-up country, Chile. The recent development of local standards in Chile by an Association indicates that there seems to be a reverse trend of Chilean local standards influencing developed counterparts in standards setting. The paper illustrates how this becomes possible through observing the leading role taken by the Association to understand the successful catching-up process of this industry.

3. Background to the industry

The salmon industry in Southern Chile represents a natural-resource based industry, which has demonstrated strong export growth since its establishment in the mid-1980s. In 2006, this industry exported approximately 628,000 tons and earned about $US 2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2007). The Chilean contribution to the world supply of salmon has increased tremendously in the past 10 years (Figure 2). As compared to the 1980s, farmed salmon currently has 70% of total production in the market. It is worth mentioning that half of that, 35%, is produced in Chile.

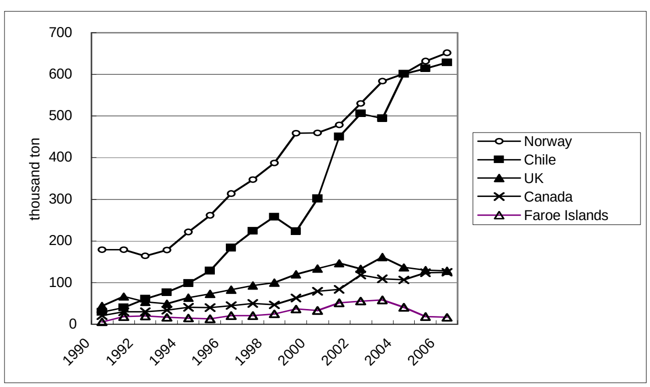

Figure 1: Main exports of farmed salmon and trout, 1990-2000

Source: SalmonChile, 2007

The salmon farming industry shares some aspects of the characteristics of many non-traditional natural-resource based industries in the region. The growth of the salmon industry followed a typical tendency of Latin American firms mentioned in the work of Cimoli and Katz (2003) – an increase in the concentration of larger firms, capital intensity of its production, and foreign ownership. However, at the same time, many studies (e.g. Montero et al., 2000; Katz, 2004; Montero, 2004; Pietrobelli and Rabellotti, 2004) have recognised the successful development of a

local production network or cluster in the industry. Furthermore, the study of Pietrobelli and Rabellotti (2004) states that this salmon cluster, compared to other natural-resource based clusters examined in Latin America, has demonstrated a high level of joint action and collective efficiency. Furthermore, studies have mentioned the important role played by institutions such as Fundacion Chile (Katz, 2004), CORFO (Maggi, 2002) and the Association of the Salmon Industry (Perez-Aleman 2005) in enhancing international competitiveness.

4. The industry and standards

The main features of standards used in this sector are explained in Box 1. These include mainly international standards used in the global market as well as local standards. Figure 2 illustrates the general compliance pattern with different standards for salmon production and the two types of input supplier. Each line indicates the degree of compliance (0 = no intention, 1 = under consideration, 2 = being planned, 3 = in process, 4 = complied) with each standard for each type of firm. The lowest compliance level is 0 and full compliance is 4.

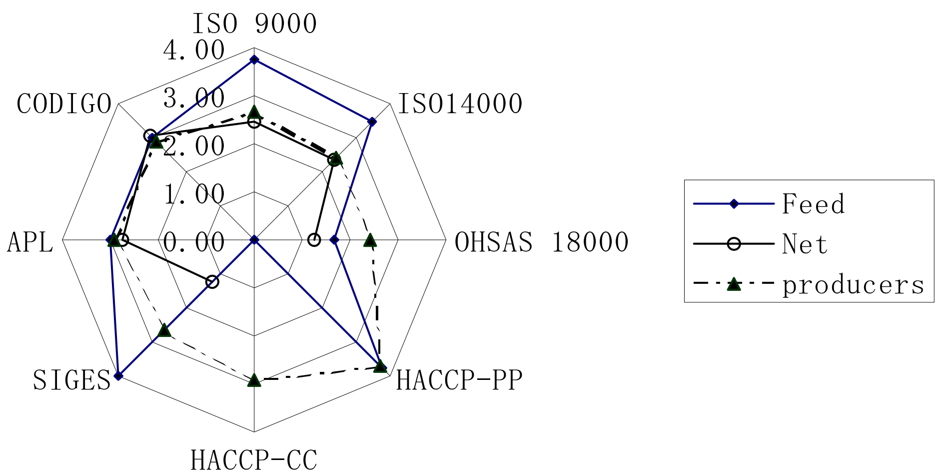

Figure 2: Mean compliance level with different standards for sample firms

Source: survey results. Note: compliance level ranges from 0 = not at all, to 4 = complete

The salmon producers seem more likely to comply with HACCP-PP and HACCP-CC, then adapted national standards for exporting firms, followed by local standards such as SIGes, APL and CODIGO. The international standards such as ISO, on average, score third highest, except that ISO 9000 scores higher than the others. The two types of input suppliers have very different patterns from producers: the fish-feed firms have distinctively high compliance levels with global standards such as the ISOs, followed by national standards, HACCP-PP and local standards such as SIGes, then followed by APL and CODIGO; the fish-net firms demonstrate relatively high compliance levels with local standards, followed by national standards and international standards, while HACCP-PP and HACCP-CC are not complied with at all. This is due to the fact that none of these net firms are engaged in

salmon production while some of the feed firms are. This illustrates that compliance levels to some degree reflect the industrial structure and characteristics of the industry, thus influencing the learning pattern of firms.

Box 1: International and local standards used in the salmon farming industry

International standards

- **ISO 9000:** A global standard for quality management
- **ISO 14000:** A global standard for environmental management
- **OHSAS 18000:** A global standard for occupational health and safety

Local standards: adapted versions of global standards

- **HACCP-CC:** Hazard Analysis and Critical Control Point, a food safety methodology for fish cultivation centres. This was originally an international standard; however, the Chilean government adapted this standard to the national level and it is now controlled by the Vice Ministry of Fishery for all of the farmed fish exported abroad.
- **HACCP-PP**: Same as above but for the fish-meat processing plants.
- **APL:** Acuerdo de Produccion Limpia (Agreement for Cleaner Production): A local certificate that emerges from a voluntary scheme to meet cleaner production guidelines agreed between industry and public sector (local and national). This is supported by the government and the Association.
- **SIGes**: Sistema Integrado de Gestion (Integrated Management System): A local standard created by the Association of the Salmon Industry that tries to integrate the necessary standards both international (ISOs) and national (HACCPs), adapting them to local conditions with an intent to differentiate those firms that are in compliance from the others. Currently this standard conforms to SQF (safe quality food) standards with the Association of Salmon Farming in Canada and the USA. This is also currently used by Wal-Mart in its procurement of salmon in Chile.
- **CODIGO**: Codigo de buenas practicas (Code of good practices): Local firm-level standards, in written form for internal use in the firm. It could vary from firm to firm depending on the activity.

Several attempts have been made locally to increase the compliance level with international standards. In this attempt to complement the missing part of standard compliance, several local standards have been created. Some attempts were made as early as the late 1980s separately by both private and public sectors. The Association, with the technical cooperation of FundacionChile – a privately run institution with the public purpose of promoting technological transfer, created the local private standard called ‘quality seal’ (sello de calidad) while the government, the National Fishery Service (Servicio Nacional de Pesca: SERNAP, later SERNAPESCA), developed the 'Sanitary Operation Procedure' (POS – Procedimiento Operacion de Saneamiento), based on the international standard HACCP – Hazard Analysis and Critical Control Point. These local attempts for standards were later unified, with HACCP-PP monitored by SERNAPESCA and the Association’s ‘quality seal’ phased out.

More recently, as many firms have not been able to obtain international standards due to the high costs as well as demanding capabilities involved, local standards were created by the Association of the Salmon Industry. These local standards attempt to assist firms with some intention of compliance to differentiate them from the others; at the same time, it tries to guide these firms to achieve compliance in the end. The local standard called SIGes (Sistema Integrado de Gestion) is the combination of many locally created standards (including one on sustainable aquaculture) as well as modified international standards.

In addition to that, APL (cleaner production certification) also exists as a local standard. This standard emerged as the result of collaborative efforts between public and private sectors to reduce waste and contamination. This scheme was called the ‘cleaner production initiative’ which first drew on a voluntary agreement between groups of related public institutions that involved monitoring different stages of production (Maritime authority, Sewage management, Waste control, Sanitation, etc.) and groups of industry represented by the Association. The certification was made by the Association to differentiate the participating and non-participating firms.

Overall, the current situation of standards in the Chilean salmon industry can be considered as in between the ‘adaptation’ and ‘modernization’ stages of a catching-up process. It is noteworthy that many local attempts have been made to facilitate compliance with international standards. It is particularly interesting to see that it is not only local efforts made by the Association that seem to indicate the potential emergence of collective action among firms, but also the increasing involvement of public institutions.

5. Methodology and hypotheses

5.1 Survey samples

A semi-structured survey was conducted with basically three types of firms in the salmon industry: the salmon producers and two kinds of suppliers, fish-feed and fish-net. Salmon production entails firms with various functions along the production line, including salmon egg producers, alvine producers (freshwater phase), salmon growers (saltwater phase), fish-meat processors (cutting, smoking, packing) and traders (exporters). The fish-feed firms sell various different types of feed to salmon growers according to the growth level of the salmon as well as types. The fish-net industry not only sells nets but also conducts various different services and products according to specialty. Due to constraints imposed by the numbers of replies and irregularities in the compliance levels of some of the standards, the primary study here confines itself to data on salmon producers and all the standards except for CODIGO. CODIGO is excluded from the analysis due to the irregularities in the data collection. Both quantitative and qualitative data are collected as the result of a semi-structured survey.

5.2 Description of sample firms

The total sample of salmon producers is 41. This covers at least 50% of total exports of the Chilean salmon industry in value terms,[1] and includes both large and small firms. 70% of the sample firms (30) are national firms while 12% are 100%-foreign firms. 60% of the sample is owned as a corporation whereas 30% are limited or family-owned. As for exports, 71% of the firms export 80% to 100% of their product while 24% do not export at all. The average period of operation is 12 years and the average number of employees is 356. The samples are well spread from single-function firms to multiple-function firms, with over 50% of the firms conducting more than 3 functions.

[1] Only larger firms are listed in the official statistics by the name of the firm; therefore, it was not possible to get the exact share of representation by the sample in export values. However, those which can be recognized already represented 50% of its value.

5.3 Hypotheses

The aim this paper is to assess whether standards compliance is influenced by the collective capability at industry level. In this paper, the capability to coordinate multiple stakeholders beyond the firm level is termed ‘collective capability’.

In accordance with this macro issue, the respective hypotheses are set out as follows:

H(0): Standards compliance in developing countries are basically firm-level actions in adapting to exogenous standards. The compliance with standards will only reflect the absorptive capacity of the individual firm and there will be no benefit from collective capability.

H(1): Standards compliance in developing countries are influenced by firm-level absorptive capacity and industry-level collective capability. In the process of compliance, the collective capability will become necessary and strengthen.

5.4 Analysis

In order to operationalise the hypotheses mentioned in previous section, variables collected through the survey are tested to see if these have influenced the compliance level of various standards used in the salmon farming industry in Chile. The variables collected are intended to represent the important factors mentioned in the preceding theoretical discussion, like absorptive capacity at the firm level (see below), firm size and collective action. The dependent variable is the level of standard compliance (with ISO 9000, ISO 14000, OHSAS 18000, HACCP-CC, HACCP-PP, SIGes, APL).

First, the variables are analysed against the compliance level of each standard; these are international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs) standards. Variables tested are: ‘EXPERIENCE’ (past experience of participation), ‘AGE’ (firm age), ‘SALES’ (size), ‘PROF’ (number of professionals), ‘ASOC’ (membership of the Association). As discussed briefly in the earlier section, these variables intend to represent firm-level and collective capacity. As for the firm level, Cohen and Levinthal (1990) assume the firm’s capacity to absorb new technology or knowledge is related to its prior experience of R&D as well as trained numbers of technical staff. Furthermore, size also was considered as the important precondition for R&D.

‘EXPERIENCE’ demonstrates the experience of the firms participating in quality standards as set up in 1993 with the Association of Salmon Industries. This was the first attempt the Association made to tackle a quality management problem to compete globally. Data on participation were not included in the survey; therefore, the names of the participating firms are picked up from the annual reports of SalmonChile from 1993 onwards. Many of the firms listed have gone through mergers and acquisitions in the past decade; thus, although there have been changes in name of such firms, if a part of the firm participated, the new firm is considered as the participant firm. It was considered that if the firm has participated in prior quality standards setting and implementation, it is very likely

that such a firm would comply with and participate in other standards such as this environmental one. This is a dummy variable (experience/no experience).

‘AGE’ is the firm’s total number of years in operation. The firms are divided into those with more than 10 years of experience and those with less than 10 years for a Mann-Whitney test. Given that quality control standards were introduced in 1993, 10 years earlier, this distinction expects to pick up the difference in firms that have experienced a learning process of creating and implementing the quality standards. This variable also aims to show whether cumulative experience of surviving in competitive market conditions has any relationship with compliance level, since standards have been one of the important issues in the industry.

‘PROF’ expresses whether the firm has more than 20 persons on its technical staff (20 is the median of the number of professional and technical staff of all the firms obtained from the survey) for a Mann-Whitney test. The percentage was included instead of the actual number, to reflect differences in the size of firms, in some estimations. However, it seems that differences in type of function the firm performs (such as between processing plant and trading) demonstrate much larger differences than the size itself in terms of sales. For instance, firms with larger numbers of employees have functions that require manual workers, such as processing plants, while functions such as trading require fewer employees and mainly consist of professional business people. Given that the purpose of the analysis is to assess resources in technical experience (using the concept of Cohen and Levinthal), it was considered more feasible to use actual numbers of professional and technical staff because this would better reflect the actual innovative capability.

The variable ‘SALES’ demonstrates the resource capacity for firms to invest in R&D. These are divided at the 50% point, which in this case was 4.75 million Chilean pesos.

‘ASOC’ is a dummy variable representing Association membership (member/non member).

The analyses are conducted on two levels. The first tries to identify the variable that influences the compliance level by conducting Mann-Whitney tests. The Non-parametric test, instead of ANOVA, is chosen due to the fact that samples are not distributed homogeneously. After identifying the effective variables, multiple regression analysis was conducted to identify the strength of each variable. The multiple regression analysis was conducted with independent variables that describe the capabilities of the firms and the dependent variable is the level of standards compliance. The standards compliance levels were grouped by converting the compliance level (0-4) into scores by allocating equal weight to each level. These scores are added up according the type of standards and an average was taken. The groupings were made as follows: all the standards (ALL), international (ISO 9000, ISO 14000, OHSAS 18000) and local (HACCP-PP, HACCP-CC, APL, SIGEs). These three groups are tested with the variables which proved to be significant with the earlier Mann-Whitney test. The groups are constructed to identify how the variables impact on the compliance level. As these compliance levels are now converted into scores, these are now

continuous variables, enabling the application of multiple regression analysis. For the multiple regression analysis, actual figures are used for ‘PROF’ and ‘SALES’ instead of initial groupings made earlier for Mann-Whitney test.

6. Results of Mann-Whitney tests

A Mann-Whitney test was conducted with the different variables that could explain the compliance with standards suggested in the hypotheses. Table 1 gives the results.

Table 1: Contributing variables for higher compliance: results of Mann-Whitney tests

Dependent		Experience		Age	Sales		Prof		Association	
	N	Asymp.Sig		Asymp.Sig	Asymp.Sig		Asymp.Sig		Asymp.Sig	
ISO 9000	40	0.014	**	0.347	0.006	***	0.001	***	0.034	**
ISO 14000	41	0.032	**	0.131	0.006	***	0.004	***	0.007	***
OHSAS 18000	41	0.447		0.444	0.702		0.028	**	0.046	**
HACCP-PP	41	0.016	**	0.149	0.001	***	0.000	***	0.000	***
HACCP-CC	40	0.032	**	0.693	0.080	*	0.005	***	0.071	*
SIGes	41	0.331		0.870	0.129		0.007	***	0.317	
APL	41	0.023	**	0.405	0.052	*	0.002	***	0.057	*

Source: survey data.

Note: Significance levels are expressed as: 1%***, 5%**, 10%*.

Groupings are made as follows: SALES: sales less than 4.75million pesos/ more than 4.75 million; AGE: more than 10 years/ less than 10 years; PROF: more than 20/ less than 20; ASOC: yes/no. Significance indicates that: firms with more than 10 years of operation, firms with more than 20 professionals, firms with experience and being a member firm of the Association would have higher compliance.

The significance level shows the significance in the difference between the two categories in respect of compliance levels. All variables except ‘AGE’ had a positive relationship with compliance level. Since some of the variables are answered in just two categories (Y/N), a Mann-Whitney test is applied to be comparable with the rest of the variables. However, when a Kruskal-Wallis test is applied for variables with multiple categories, the significance level was higher for those variables that were already significant according to the Mann-Whitney test.

Among the four variables for absorptive capacity, the results of the Mann-Whitney test showed significance for ‘EXPERIENCE’, ‘PROF’ and ‘SALES’. The significance level is particularly strong for the variable for number of professionals. This means that the firm’s own technical capability, in this case absorptive capacity, has strong influence over raising the standards compliance level.

An equally significant difference in the level of compliance was observed with the variable for Association membership, ‘ASOC’. This could mean the compliance level has much to do with a collaboration as well as firm-level capacity. However, with this analysis, it is not clear which is the stronger factor in improving the compliance with standards.

It is also noteworthy that greater variability is observed in the results between international standards – ISO 9000 and ISO 14000 in particular – and local standards, HACCP-CC, HACCP-PP, APL and SIGes. The next step of analysis therefore tries to uncover the above issues.

7. Multiple regression analysis

This section aims to identify which variable is more strongly associated with higher compliance levels. In order to examine this, multiple regression analysis is applied with variables which had significant results in the Mann-Whitney analysis. These were 'EXPERIENCE', 'SALES', 'PROF' and 'ASOC', for the standards compliance scores, 'all', 'international' and 'local'. Multiple regressions with stepwise entry of the variables were chosen to select the best fitting model. The results are set out in Table 2. The result demonstrates that, as far as higher compliance with all standards is concerned, individual firm capacity (PROF), as well as collective capacity (ASOC) are important. There are however differences in the way the variables influenced international and local standards. For international standards, 'SALES' is a single variable that affects the higher compliance level, while for local standards, 'PROF' and 'ASOC' are the variables that induce higher compliance.

Table 2: Result of multiple regressions on standards compliance

variables	All	International	Local
Constant	9.458 ***	1.232 ***	3.907 ***
	(5.510)	(6.160)	(5.063)
Sales		0.016 **	
		(4.085)	
EXPERIENCE			
PROF	0.028 **		0.013 **
	(2.121)		(2.195)
ASOC	5.658 **		2.195 *
	(2.046)		(1.807)
Model fit	0.002 ***	0.000 ***	0.018 **
F	8.003	16.683	3.635
R square	0.381	0.373	0.384
Adjusted R square	0.333	0.351	0.368
df	28	29	29

Source: survey data. Note: ***1%, **5%, *10%.

The result confirms the conventional view that international standards require resources as represented by the variable, 'SALES'. It is, however, worth observing that firm-level technological capacity represented by 'PROF' and collective capacity represented by 'ASOC' are both important for complying with local standards.

8. Collective capability and the role of the Association for the Chilean salmon industry

The qualitative data seem to support the statistical evidence presented above in terms of the role of the Association for standards compliance. It is acting as a coordinating institution for local standards, though its activities have expanded significantly in recent years. For instance, the Association opened its membership to supplier industries

such as packers, fish-feed producers, transporters and other services in 2002. In this way, it started to consolidate the industry with various different actors.

At the international level, the Association of Chilean Salmon Industries (SalmonChile) became involved with other salmon farming industry associations in the USA and Canada to establish the Association of American Salmon (Salmon de las Americas: SOTA) in 2003. This helped them establish external linkages for direct communication without being dependent on government-to-government channels.

The Association also played an active role in the establishment of regulations specific to the aquaculture sector, collaborating closely with the government. In 2001, DS No. 320 of the Ministry of Economics issued Environmental Regulations for Aquaculture (RAMA). These regulations established a series of new requirements for the environmentally sustainable development of aquaculture in order to prevent, mitigate and correct associated impacts. Following this regulation, in January 2002, regulations of measures for protection, control and eradication of diseases of high risk for hydrobiological species, also known as the sanitation regulation (RESA), took effect. The Association was requested by the government as an institution able to bring both local and global views.

The government also attempted to strengthen its role in the coordination of the aquaculture sector during this period, as aquaculture became one of the major sources of income from exports. In 2002, the Under-secretary of Fisheries (Subsecretaria de Pesca) created the National Commission for Aquaculture (Comision Nacional de Acuicultura) together with the publication of the National Aquaculture Policy (Politica Nacional de Acuicultura en Chile: PNAC) in 2004 (SubPesca, 2003). This is noteworthy since this provided, for the first time, a common floor to discuss future policy and strategy for aquaculture with all the related public institutions as well as the different private sectors represented by distinct associations (based on interviews with SubPesca, 2004). Again, the presence of the Association in such activity was considered crucial.

As far as the implementation and enforcement of regulation are concerned, the government opted for a more collaborative approach with the private sector. One typical example of this private-public collaboration is the Cleaner Production agreement. This is an agreement between the government and groups of private industries, committing them to using environmental-friendly work methods, choosing to recycle and optimize the use of materials in the aquaculture production sector through voluntary means. Based on this agreement, the Association developed the set of standards called APL, which is granted to firms complying with this agreement. This demonstrated that not only was the Association capable of bringing firms together to engage in voluntary setting of their own standards but also monitoring those who subscribed to this agreement.

The above evidence demonstrated how SIGes were constructed. This suggests that the Association, through collaborating with various stakeholders in attempting to bring standards compliance, became increasingly the path-finding institution, capable of managing various different sources of knowledge and coordinating, sometimes even

negotiating, among different stakeholders to maintain a common platform of standards for the many groups. The Association's involvement in various activities, at distinct levels, has created a positive environment for establishing and negotiating standards with global players. Figure 4 provides a conceptual map of how the Association is actually linking many different actors together with collaborative projects.

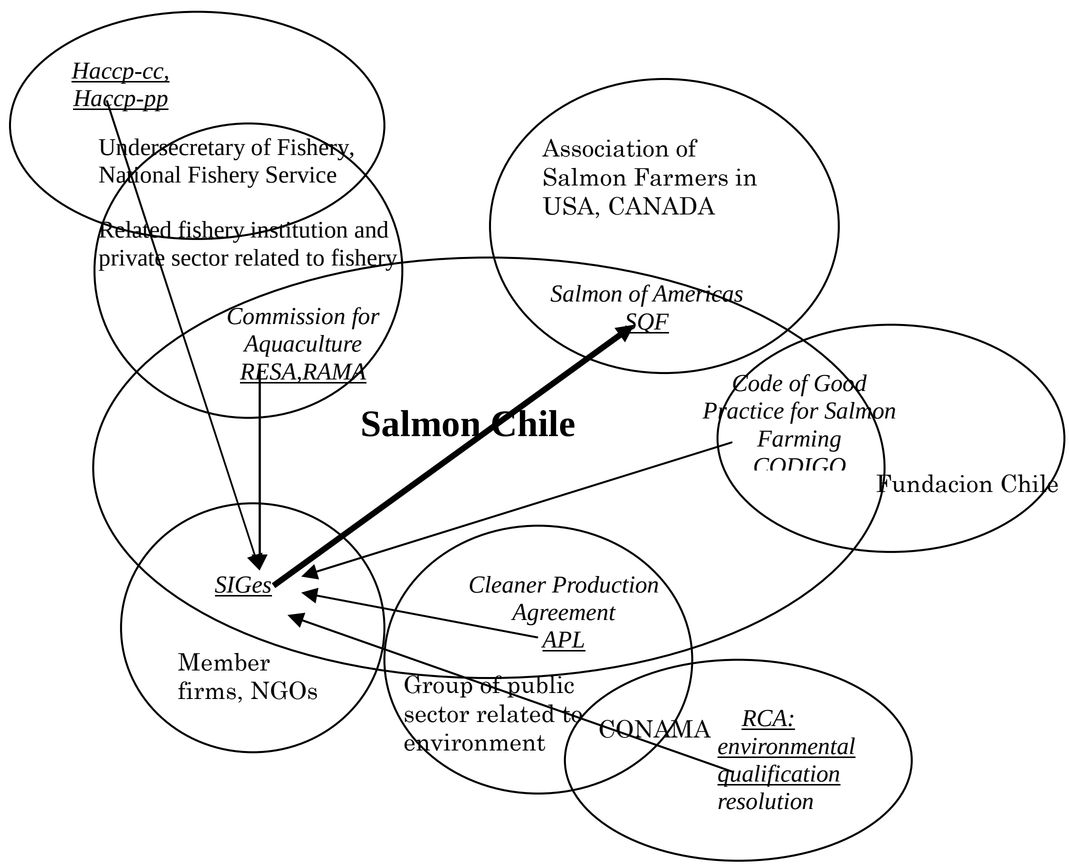

Figure 4: Conceptual map of the Association (Salmon Chile) as interface of different stakeholders through standards: example of establishing regional standards, SQF-SOTA

Note: Names of projects are in italics and the participants are in ordinary font. Underlined italics are the names of standards.

The role of the Association in standard-setting is noteworthy as they initiated two of the local standards, SIGes and APL (see Box 1 for a more detailed explanation) to enhance the capability of the industry in global markets. SIGes is particularly considered as a successful case of standard setting. This is a local set of standards that try to encompass all the relevant standards for this industry. This thus creates a platform of basic standards that local firms need to comply with or attempt to do so. At the same time, this standard has started to influence external standard-setting procedures. In 2004, standards based on SIGes were adapted as industry-wide standards among Chilean, Canadian and American salmon farming firms associated with SOTA (Salmon of the Americas), formally qualified as Safe Quality Food (SQF)-SOTA. In other words, the Chilean standards are currently an important influence on

standard setting at the level of the American continent. Furthermore, SIGes is currently adopted by Wal-Mart as a standard for procurement for salmon. This demonstrates that standards are not always externally created to govern producers in developing countries.

Despite firm-level capacity, represented by the number of professionals, being the most important factor in determining the compliance level, the above qualitative data illustrate that membership of the Association provides a nexus for the firms' capacity to interact to bring higher compliance levels. At the present time, the role of the Association is limited to the compliance level of local standards; however, qualitative evidence demonstrates the potential for influencing international standards through learning and enhancing collective capability. In other words, the Association is acting as an interface for other stakeholders involved to comply with standards, such as government entities as well as in the private sector. The regression results based on the survey demonstrate that Association membership has a significant influence on higher attainments in local standards. Despite these results not showing a strong significance for international standards, the activities currently taking place with Salmon of the Americas (SOTA) hints that the role of the Association is currently evolving from a local facilitator of collective action to a more global level entity.

9. Final interpretation of results and conclusion

The above results and following analyses seem to indicate that there is a chain of iterative action, which may have been repeated within the industry as the industry became competitive. This can be conceptualised as follows:

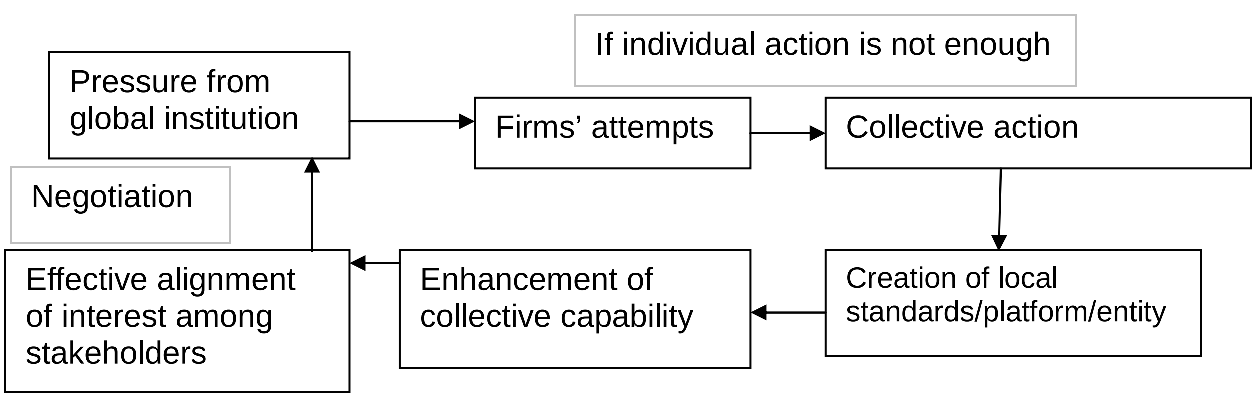

Figure 5: Conceptual map of dynamic capability of the Association

The above analysis and the qualitative information demonstrate how collective capabilities are enhanced through interaction with external demands. The analysis of the compliance level of standards in the Chilean salmon industry shows that these firms are not 'passively' complying with the international standards: in the course of adapting the standards, they are increasingly 'actively' learning and equipping themselves through creating local standards with capability at a collective level such as through the Association, in a spiral form that recalls Knowledge Management approaches (Nonaka and Takeuchi, 1995). The emphasis is also in line with the concept of 'architectural' innovation by Henderson and Clark (1990).

Although the process of compliance with standards begins with a one-way power relationship and associated flow of knowledge and information, such one-way flows may become consolidated into two-way inter-linkages when power balances themselves reverse with the development of local capability in catching-up countries. The establishment of appropriate local institutions then enabled stakeholders to work collectively on the content of negotiating the standards and to invest further in technology itself. This suggests an alternative sequence of developing innovative capabilities that starts from 'architectural' (Henderson and Clark, 1990) to conventional 'radical' and/or 'cumulative' innovation. The unique feature of this case is its unit of analysis that goes beyond the firm level, addressing dynamic re-defining of sectoral boundaries through the learning process.

In a globalizing market, privately managed standards are increasingly being used. In this context, standards compliance is generally seen as an additional set of tasks for entering the global market. Nevertheless, it is important to consider that standards compliance also requires organizational development as an interface and provides learning opportunities to create the capacity to manage diverse knowledge flows from horizontal and vertical relationships – local/global, tacit/codified, and user/ producer.

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